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Readiness

BARE BASE CONCEPTUAL PLANNING GUIDE



DEPARTMENT OF THE AIR FORCE



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This volume in this pamphlet series describes the Air Force engineer's role in the establishment and operation of a bare base (defined as a site with a usable runway, taxiway, parking area and a source of water which can be made potable). It lists civil engineer tasks involved in the forward projection of airpower, with emphasis on the use of Harvest Falcon and Harvest Eagle mobile facility assets. This volume is of particular importance to unit-level civil engineer planners and mobility team chiefs in their preparation for bare base wartime and contingency operations. This pamphlet series supports AFI 10-210, Prime Base Engineer Emergency Force Program and AFI 10-211, Civil Engineer Contingency Response Planning. Send comments and suggested improvements to HQ AFCESA/CEX, 139 Barnes Drive, Tyndall AFB FL 32403-5319.

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Chapter 1

INTRODUCTION



1.1. References, Abbreviations, Acronyms, and Terms. Related publications, abbreviations, acronyms, and terms used in this volume are listed in attachment 1.

1.2. Purpose. This volume of deployment and employment information for contingency forces and equipment was developed in response to a great demand for data on this subject from field units, engineer planners, logistics planners, and others involved in bare base activation. The adherence to a policy of global response and the large procurement of beddown assets to support multiple locations created the need for a comprehensive collection of information, schedules, and drawings in all areas of construction, erection, operations, and maintenance of bare base facilities and equipment.

1.3. Scope. The materials in this volume, designated primarily for a hypothetical bare base in Southwest Asia, are most useful when employed as a starting point to bare base planning for a specific location which has its own special requirements. Such useful features as base and facility group layouts, facility guide matrices, utility layouts and drawings, manpower requirements, etc., can be used and adapted to meet any site specific bare base location.

1.4. Background. The closure of many main operating bases (MOB) overseas and reluctance of many nations to permit establishment of permanent foreign military bases on their soil have limited the basing options for U.S. forces during contingency operations. This situation has increased the importance of the bare base concept as a viable solution to contingency and wartime basing shortfalls and requirements.

1.4.1. A bare base, by definition, is a site with a usable runway, taxiway, parking areas, and a source of water that can be made potable. It must be capable of supporting assigned aircraft; and providing other mission essential resources such as a logistical support and services infrastructure composed of people, facilities, equipment, and supplies. This bare base concept requires mobile facilities, utilities, and support equipment that can be rapidly deployed and installed, and be available to transform - virtually overnight - undeveloped real estate into an operational air base. Fortunately these kinds of assets have undergone more than three decades of intense research and development.

1.4.2. Earlier requirements for mobile air bases sprang out of necessity with the advent of modern air warfare. During World War II, mobility concepts specified that ground forces advance in increments by surface means. The advancing force had to continue the offense. At the same time, they were required to establish new operating bases. The tactical air units moved

from one forward operating base to another in order to keep up with and provide air support for the advancing troops. Tactical units had two choices - build base facilities or erect tents and substandard billets and operate and perform maintenance out in the open. This vicious cycle repeated itself whenever battle zones changed. Similar problems were experienced in Korea.

1.4.3. It wasn't until the 1950s that military planners developed techniques to prepackage base support equipment - predominantly World War II hardware. This equipment consisted mainly of tents, field kitchens, medical facilities, power generators, cots, desks, and other equipment. It was bulky, heavy, and required excessive manhours to position and erect. This initial deployment kit was given the nickname Gray Eagle. In the mid-1960s, more equipment was added to the package. Some was redesignated to make it more air transportable, and the name was changed to Harvest Eagle. Harvest Eagle was tested many times in worldwide deployments including Southeast Asia.

1.4.4. A major innovation emerged in the late 1960s when a new concept for mobility was born. Under this concept, all facilities and equipment would be lightweight, modular, and designed to be C-130 transportable. Some shelters would be hardwall and serve as their own shipping containers. Some of the mobility hardware would interface with weapons systems while other hardware would be developed to take care of transportation, housing, messing aircraft maintenance, airfield lighting, power, water, sewage, heating, cooling, medical, and civil engineer needs. This concept would have everything necessary to support a deployed force in the most austere environment. To test this concept, exercise Coronet Bare was launched in October 1969 to evaluate new prototype equipment which was called "3782 equipment" after the contract number under which it was purchased. In November 1970, the full-scale deployment Heavy Bare exercise successfully validated the bare base mobility concept of being operational within 72 hours. After validation, the program became known as "Weapon System 437A, Harvest Bare."

1.4.5. In the early 1980s another iteration in the history of bare base facilities occurred. To support the Air Force portion of the Rapid Deployment Joint Task Force, the forerunner of U.S. Central Command, a major equipment buy was performed. Instead, however, of procuring duplicate Harvest Bare packages, a mix of hard and soft walled facility assets was obtained. This facility mix was lighter to airlift than Harvest Bare and eliminated several types of facilities which had proven to be maintenance intensive during past deployments. In addition to facility and utility systems, this new mobile bare base package, nicknamed Harvest Falcon, contained several other major components. Typical of these components were vehicles, engineer equipment, communications gear, medical facilities and equipment, user unique tactical shelters, mobile flightline maintenance equipment, and tanks, racks and pylons. The Harvest Falcon mobile package provided admirable support for several major multi-national exercises in the 1980s and during the Iraq War in 1990-91. Sufficient Harvest Falcon equipment exists to support approximately 55,000 personnel. The vast majority of the assets are prepositioned overseas for Southwest Asia support. A small number of assets (approximately 4,400 personnel) are available at Holloman AFB for worldwide deployment.

1.4.6. In today's world, the concept of the bare base is more important now than ever before. While many foreign countries resist development of major fixed installations on their soil, they, themselves, are subject to internal and external aggression. As a rule, these nations possess runways, taxiways, and air terminal facilities which could be offered to our forces during contingency situations. In fact, there are hundreds of potential bare bases in the world which could support air operations even though they may be limited and often inadequate. If it is decided it is in the national interest of the United States to assist these nations in times of turmoil, the Air Force must have the capability to deploy to and operate from air bases that are provided regardless of infrastructure availability. Today's mobility concept is to rapidly deploy a force, complete with shelters and facilities, capable of independently supporting and launching sustained combat operations with the same independence as fixed theater installations.

1.5. Planning Processes. This ambitious mobility concept presents problems and challenges to engineers, planners, and developers who have the ultimate responsibility of bare base development. Consequently, this conceptual planning guide (CPG) was developed to highlight key features and considerations associated with bare base planning, describe the types of shelters, utilities, and support items available for bare bases, and address the general procedures for installing and erecting these assets. It also provides a concept of employment and a sequence of bare base construction. The CPG is a road map that leads the bare base planner from the initial planning response phase to the material acquisition phase. It is, in effect, a checklist to ensure each crucial item which affects the base's ability to function is covered. The CPG does not present the final or specific solution to a given problem. It is not expected to solve all the anticipated problems, nor is the CPG designed to anticipate all the problems that might be encountered. Hopefully, this CPG addresses those that most likely would be encountered and gives guidance, as a checklist does for a pilot, so some important aspects of the task will not be overlooked. While the CPG was developed for use anywhere in the world, it deals most heavily with the Southwest Asian theater of

operation. Additionally, the CPG primarily addresses potential bare base locations that do not consider any form of major host nation support or other service support being available, i.e., USAF forces will stand alone at an installation. This situation is normally viewed as a worst case scenario. In many cases, however, a bare base could be the host of several diverse occupants, for example, host nation military units, host nation civilian agencies, allied military units, and forces from other US services. These co-occupants may provide a planner with many challenges since responsibilities and jurisdictional areas will have to be jointly determined. Factors such as facility usage, equipment allocation, work taskings and manpower support will have to be worked out to the agreement of all parties. Obviously these items have an immediate effect on a planner's initial efforts and must be addressed early in the bare base development process. They could impact such features as airlift flow of bare base assets, sequence of construction, projected use of local materials, and allocation of mobile facility assets.

1.5.1. Additional data must be gathered to supplement this CPG since it does not take into account any site specific characteristics such as existing facilities, airfield configuration, topography, climate, soil conditions, or vegetation. Major commands with their deploying wings have the primary responsibility for developing site specific layouts. For potential bare base locations named in Operations Plans (OPLANs), units responsible for site specific planning are easily identified since they will be shown as deploying forces in the time-phased force and deployment list. For short notice deployments which have not been preplanned, units responsible for site specific planning will be those first on the scene. Regardless of which units or individuals are responsible, they must gather this extraneous site specific data from intelligence sources or first-hand observation prior to laying out their plans. This is important since a well-planned and executed deployment hinges on the planner's ability to produce a comprehensive site layout, complete to the very last detail.

1.5.2. In the data gathering process, one of the first pieces of necessary information to obtain is the threat analysis for the bare base. This information should be available from the wing intelligence office. It is essential to know whether the base is located in a forward or rear area, even when the distinction between the two is blurred. The reasons are threefold:

- Aircraft must survive while on the ground.
- Aircraft must be able to get airborne to perform their mission during or after attack.
- Logistics infrastructure must survive to sustain future air operations.

A threat analysis will determine whether individual facilities and facility groupings will be dispersed or nondispersed, whether electrical and water plants will be dispersed or centrally located, and whether revetments and rapid runway repair sets will be required. In some of the more forward areas it may be necessary to plan camouflage and decontamination capabilities.

1.5.3. Topography data should reveal prevailing wind direction and expected velocity, humidity, temperature extremes, annual rainfall, natural slope of the terrain, soil characteristics and latitude and longitude of the bare base site. These data are required to properly site sewage lagoons downwind, determine air conditioning and heating requirements, construct cantonment areas away from natural water drainage during flash floods, determine absorption rates of the soil and locate facilities in such a way as to minimize shadows that can be detected through aerial reconnaissance.

1.5.4. It is important in the preliminary planning stage to know the location of existing facilities and utilities. Consequently, any layouts, drawings, aerial photographs, etc., are vitally needed. Equally important are the lengths and widths of the runway, taxiways, ramps and aprons. Does runway lighting exist? If so, is it adequate? Is there a requirement for aircraft arresting barriers? What kinds of water sources are available? Is the water fresh, brackish or salt water? Does it come from a well, river, lake, or the ocean? What is its temperature? How far away is the source? Is the site being developed using hardwall or soft-wall shelters? There are many more questions, but the more answers that are provided, the easier the job.

1.5.5. Having accumulated as much data concerning the bare base as possible, it is now time to map out the specific details on the base plans. Following guidance in the CPG, planners must develop each of the different systems, keeping in mind that the CPG is the "worst case" scenario. In the CPG, for example, a five-day supply of water is required for each individual on the site. This water may be pumped from a source up to two miles away, purified with reverse osmosis units and stored in collapsible rubber bladders. If, however, the planners find that purified water is available on-site in the quantities required, then the requirement for water production equipment falls dramatically.

1.5.6. Priorities cannot be overemphasized during bare base development. The allocation of engineering resources must be balanced between both mission essential and force beddown taskings. Thus, commanders of various organizations at all echelons must understand the importance of establishing clear mission priorities. Increased engineer requirement, especially during the bare base erection phase, could cause limited engineer resources to be thinly spread. For example, the CPG calls for the individual organizations on base to erect their own shelters with minimum technical aid from engineer personnel. If this requirement is circumvented and the engineers are tasked to erect everyone's shelter, the total impact on scarce engineer

resources will cause great delays in establishing utility systems and in the accomplishment of other critical tasks. This could be detrimental to the mission.

1.5.7. Successfully erecting a bare base within a predetermined time schedule depends on many factors controlled outside of engineer channels:

- Mobility assets must arrive in proper quantities and sequence.
- Motorized support equipment such as forklift, trenchers, and trucks must be available in the required quantities.

Craftsmen must be trained to erect, operate, and maintain all of the bare base equipment.

Chapter 2

COMBAT AIR BASE PLANNING



2.1. Introduction. There are several types of installations on which U.S. forces may have to operate during wartime or contingencies. For example, these could include main operating bases, collocated operating bases, standby bases, forward operating locations, and bare bases, the subject of this volume. Some of these types of installations, such as the main operating base, may be fairly well developed; whereas others may be quite austere from an infrastructure perspective. Regardless of how extensively a base has been built, however, it must meet one basic common criterion -- can it support its wartime and contingency missions adequately. The subject of this chapter, combat air base planning, addresses a process which can be used to determine base infrastructure requirements predicated on these wartime mission needs. While bare base mobile assets are packaged in distinct sets to support various population levels, use of the combat air base planning process serves as a way of ensuring all facility and utility requirements are identified, major siting considerations are considered early, and key survivability and operational features are addressed. First discussed will be Joint Chiefs of Staff (JCS) wartime construction standards, followed by JCS planning factors. The combat air base planning process will then be reviewed.

2.2. JCS Standards of Construction. The standards of construction established by JCS determine the types of materials and construction techniques used in wartime or contingency operations. These construction standards are designed to provide criteria which minimize engineer effort while providing facilities of a quality consistent with the mission requirements, personnel health and safety, and the expected availability of construction resources. The two types of construction standards that most commonly apply to wartime operations are initial standards and temporary standards. The initial standard is characterized by relatively austere facilities and utilities, intended for use during the first six months or so of a conflict. Examples of such facilities are tents, slit trench latrines, and low voltage electrical distribution systems. The temporary standard is characterized by facilities and utilities of a more substantial nature. They are intended to increase efficiency of operation and their use is normally up to 24 months. Examples of these types of facilities include wood frame buildings, bolted steel fuel tanks, and paved roads. Our Harvest Eagle and Harvest Falcon mobile facility assets are considered to be initial construction standards. This connotation, however, does not mean they will be totally replaced after six months; but rather that they will be used by Air Force forces at the onset of a conflict. It is not inconceivable that some of these mobile assets will last several years before needing replacement.

2.3. JCS Planning Factors. While standards of construction dictate the type of facility to be used, wartime planning factors dictate the scopes of facilities. They are also provided by JCS. When these planning factors are applied, they will normally yield substantially smaller facility scopes than do the factors used for peacetime Operations and Maintenance (O&M) or Military Construction (MILCON) planning and construction. Most of the planning factors are applied against the numbers of aircraft or population to be at an installation. In some cases, however, the planning factor itself provides the facility scope, such as 2700 SF per air base for a refueler maintenance shop. A comprehensive listing of unclassified wartime planning factors can be found in attachment 2 to this volume, Volume 6 of this pamphlet series or Annex S to the USAF War and Mobilization Plan, Volume I. A more complete listing that includes some planning factors classified secret is found in MJCS 275-89, Planning Factors for Military Construction in Contingency Operations.

2.4. Combat Air Base Planning Process. The combat air base planning process provides a methodology for determining wartime air base facility and utility requirements, identifying the necessary attributes of the assets chosen to fulfill the requirements, and evaluating the effectiveness of an installation's collective facility and utility network in supporting the base's operational mission. The process itself is somewhat mechanical; however, there are decision points at various intervals which are best addressed by personnel familiar with base and contingency operations if they are available. Field experience is a very valuable teacher. Once the process has been completed for a particular air base, one can be relatively sure the facilities and utilities network to be provided has been balanced with the mission requirements, threat conditions, and operational needs of the installation.

2.4.1. The initial step in the overall process is an analysis of three key planning items--the missions to be performed at the base, the anticipated threat conditions, and the situation. The situation normally includes the numbers of aircraft, the total base population, base static data, and political climate in terms of host nation support and existing facility/utility use.

2.4.1.1. The primary mission of an installation is usually rather straightforward, e.g., a base supporting counterair operations, an aerial port, a strategic bomber base, etc. Keep in mind, however, that other missions or requirements may be present. For example, most bases will eventually be resupplied by air; therefore, the capability to handle large frame aircraft must be considered. Some bases may also serve as staging bases for US Army forces which may affect support operations. These types of options must be ferreted out before planning can begin. Good sources of mission-related information are the aircraft operations planners at unit level and the all-service Timed-Phased Force and Deployment Data (TPFDD) associated with the air base in an operations plan (OPLAN). The TPFDD is basically a database containing all forces and their deployment timing required to deploy in support of an OPLAN. If all potential missions cannot be reasonably well defined, some assumptions may have to be made with respect to total mission requirements.

2.4.1.2. The threat conditions should be obtained from the wing intelligence office. The anticipated types of attacks, their possible intensity, and probable types of weapons to be used will need to be known or at least estimated. The entire range of attacks must be investigated--not only the aircraft, missile, and ground possibilities, but also those of lesser strength such as terrorist, paramilitary forces, and saboteurs. The types of weapons are also important since conventional bombs, chemicals, and car bombs, for example, could all drive different facility and hardening configurations when that portion of the planning process is reached.

2.4.1.3. Considerable data are necessary if the overall base situation is to be fully understood. The number and types of aircraft, base population over time, transient forces and expected duration of the operation can usually be obtained from the operations plan being considered. If there is doubt, the wing plans office should be able to help clarify the overall picture. Information concerning the base itself is also required. This can take the form of base maps, aerial photographs, construction drawings, past site surveys, and data contained in various documents accumulated by the intelligence office. In some cases base support plans or joint support plans may be available. Sometimes a member of the deploying unit or someone from the major command (MAJCOM) staff who has been to the installation can provide current information. All sources have to be investigated, including those involving the political arena. Information pertaining to the willingness of the host nation to provide facility support, joint use of assets, etc., has to be accumulated. Oftentimes the base/joint support plans and the MAJCOM staff can help.

2.4.2. Once all the sources of data have been tapped as much as possible, it is time to analyze what is available. It is often valuable to list the pertinent facts and assumptions as they are generated by the analysis. The intent is to develop the biggest picture possible of what conditions may have to be faced. For example, the fact that an adversary has a certain type of aircraft mix could mean that an air attack should be expected and hardening and dispersal actions should be considered. The fact that no aircraft shelters exist will mean that some form of aircraft revetment will be necessary. The fact that the US MILCON

program provided some of the base facilities means that some facilities will be available for US use. The fact that the adversary has a chemical munitions capability means that a chemical attack is possible and decontamination areas and shelters should be considered. The list could go on but the intent has been shown. This analysis of base situation, threat, and mission provides an overall framework upon which to base more detailed efforts. Before proceeding any farther, however, the analysis should be reviewed with the wing command section to ensure no major items have been overlooked and the planning is headed in the right direction.

2.4.3. The next step in the process is highly mechanical but serves as the base line for facility and utility requirements. Each type of facility and its associated planning factor from attachment 2 is applied against the appropriate aircraft or population number and the resulting basic requirement figure is determined. For example, the planning factor for emergency troop housing is 50 SF per person. If the population was to be 2200, the basic requirement would be 110,000 SF. Table 2.1 illustrates several other basic requirements calculations. Once all facility and utility types and basic requirements have been listed, the application of combat air base planning principles is started.

2.4.4. Combat air base planning principles are precepts derived and validated from past experience and application. In the context of the combat air base planning process they are compared against the basic requirements that have been calculated to see what special considerations should be made with respect to satisfying the facility or utility need. It is probable that not all principles will be applicable to all facility and utility system requirements. In fact, there may be some facilities or utilities that none of the principles will relate to. Nevertheless, if time permits, it is prudent to look at each identified facility and utility individually when the principles are applied. This action gives a more complete product and lessens the chance that something will be overlooked. There are ten combat air base planning principles that will be addressed.

Table 2.1. Sample Basic Requirements Calculations (Two Fighter Squadrons (36 PAA)/2200 Personnel).		
FACILITY DESCRIPTION	PLANNING FACTOR	BASIC REQUIREMENT
Squadron Ops	9,000 SF/Ftr Sqd	18,000 SF
Aircraft Revetment	1/Ftr Aircraft	36 ea.
Electrical Power	2.7 kW/Per	5940 kW
Troop Hsg	50 SF/Per	110,000 SF
Base Operations	5,055 SF/Air Base	5,055 SF

2.4.4.1. Redundancy. Redundancy relates to the provision of alternate or backup critical facilities or resources. For example, an alternate Damage Control Center and Survival Recovery Center should be established to ensure an unbroken command and control capability.

2.4.4.2. Resiliency. Resiliency refers to the capability of a facility or system to be used for multiple purposes during wartime. Utility systems that are provided in a looped configuration yield a degree of resiliency--they often can be severed at some point, yet be quickly put back in operation with minimal loss of capability. The temporary use of a hardened aircraft shelter as a personnel or vehicle protective shelter is another example of resiliency.

2.4.4.3. Reliability and Maintainability. Reliability and maintainability relate to the operational dependability of a facility or system. A power production system that has an established parts resupply chain and is capable of continued service over an extended period of time is an example of reliability and maintainability.

2.4.4.4. Interoperability. Interoperability concerns the use of standardized facilities and systems that can be interchanged quickly. Examples of interoperability would be a system of standard fittings and couplings that interconnect a mobile and permanent fuels supply and storage system or standard class L-type electrical connectors on all low voltage cable connectors.

2.4.4.5. Accessibility. Accessibility pertains to the physical location of facilities that permits efficient interface between related activities and functions. The pavements capability for fighter aircraft to rapidly access the runway from alert parking areas or quickly clear the runway after landing is an example of accessibility.

2.4.4.6. Sustainability. Sustainability concerns the ability to maintain operations and generate sorties for the duration of a conflict. It requires self-sufficiency for a defined period of time with minimum dependence on off-base resources and includes the practice of conservation of resources to minimize expenditure and loss of critical war materiel. The stockage and use of war reserve materiel illustrates the principle of sustainability.

2.4.4.7. Warning, Assessment, and Control. Warning, assessment, and control refers to real-time situation assessment and communication of important combat information. Typical examples include establishment of a giant voice system, use of automated chemical agent detectors, and provision of a dedicated multi-channel engineer radio net.

2.4.4.8. Plan for People. Plan for people relates to the recognition of human factors in facility layout, design, and operations. Provision of adequate personnel protective shelters with sufficient ventilation and sanitary facilities exemplifies the plan for people principle.

2.4.4.9. Protection of Resources. Protection of resources concerns the physical protection of facilities, their contents, and utilities as well as evacuation and base denial. Camouflage, concealment, and deception (CCD) efforts and expedient hardening are examples of protection of resources.

2.4.4.10. Combat Siting. Combat siting refers to the selection of the place that ensures optimum force projection, defensive effectiveness, access to critical resources, and resupply routes. Use of natural terrain and placement of obstacles to enhance base defense are examples of combat siting.

2.4.5. Table 2.2 illustrates how the combat air base planning principles are applied to various types of basic facility and utility requirements. In our example a basic requirement for 18,000 SF of squadron operations facilities supporting two fighter squadrons is identified. If the threat assessment indicated that air and ground attacks were possible, at least five principles appear to be appropriate toward these facilities. Protection of resources applies since these facilities will house aircrew members and their flying gear. Redundancy is pertinent since squadron operations facilities also serve as command and control centers. The accessibility principle applies since aircrew members have to be relatively close to the aircraft parking areas during wartime. Because the squadron operations facilities are also command and control facilities, reliability of support systems is important. Lastly, since aircrew members could be operating out of these facilities for extended periods of time, the plan for people principle applies with respect to environmental conditions.

Table 2.2. Combat Air Base Planning Principles Application.			
FACILITY DESCRIPTION	PLANNING FACTOR	BASIC REQUIREMENT	PRINCIPLES APPLIED
Squadron Ops	9,000 SF/TFS	18,000 SF	Protect Resources Redundancy Accessibility Reliability Plan for People
Aircraft Revet	1/Ftr Acft	36 ea.	Protect Resources
Elect Power	2.7 kW/Per	5940 kW	Redundancy Resiliency Sustainability Interoperability Protect Resources Reliability
Troop Hsg	50 SF/Per	110,000 SF	Plan for People Protect Resources
Base Operations	5,055 SF/AB	5,055 SF	Protect Resources Reliability

2.4.6. The next step in the planning process involves determining the "effect" the application of the planning principles has on the basic facility and utility requirements. Table 2.3 depicts the effects of the principles application on various types of facilities and utilities. For example, the protection of resources principle will mean that facility revetments, dispersal actions and various CCD techniques would be appropriate. The redundancy principle would infer that the two squadron operations complexes would be separated and capable of backing one another up. The accessibility principle would mean that both squadron operations facilities should be sited in proximity to the flightline area. The application of the reliability principle would lead to the provision of backup power. Lastly, the plan for people principle would indicate that air conditioning and ventilation should be provided. For personnel who have limited experience in contingency planning activities, a review of Volumes 1 and 2 of this document series should provide a better understanding of what options and techniques can be used to satisfy the effects of principles application.

Table 2.3. Principles Application Effects.				
FACILITY DESCRIPTION	PLANNING FACTOR	BASIC REQUIREMENT	PRINCIPLES APPLIED	EFFECT
Squadron Ops	9,000 SF/TFS	18,000 SF	Protect Resources Redundancy Accessibility Reliability Plan for People	Revetments Siting CCD Backup Power Air Cond/Vent Dispersal
Aircraft Revet	1/Ftr Acft	36 ea.	Protect Resources	N/A
Elect Power	2.7 kW/Per	5940 kW	Redundancy Resiliency Sustainability Interoperability Protect Resources Reliability	Backup Power Protection On-Site Fuel Storage Dispersal Revet/CCD Fencing/Berm
Troop Hsg	50 SF/Per	110,000 SF	Plan for People Protect Resources	Siting Air Condition Dispersal Revetment
Base Operations	5,055 SF/AB	5,055 SF	Protect Resources Reliability	Revetment Backup Power CCD

2.4.7. The determination of adjusted requirements is the next action in the combat air base planning process. These requirements are basically a compilation of the data derived from the planning factors and the effects generated by the principles application. Usually the adjusted requirements will be a more detailed expansion of the basic requirements as shown in Table 2.4. In our squadron operations facilities example, backup power, revetments, and CCD measures were added to the basic requirement of 18,000 SF due to the impact of applying the principles of resource protection and reliability. Using the adjusted requirements, various "sets of facilities" can be developed which will satisfy the overall facility or utility need. In the case of the squadron operations facilities used in our example, one facility set might be the use of existing facilities previously built through the MILCON program assuming the data initially accomplished showed such facilities to be available. If the buildings were semi-hardened and provided with standard filtration and backup electrical systems, many of the adjusted requirements would be quickly satisfied. Another possibility might be the use of Harvest Falcon assets along with bin revetments and mobile generators. A third possibility might be a mix of mobile facility assets and existing facilities. In most cases one facility set will stand out from the rest as the most reasonable arrangement--normally because it will best satisfy the requirement, be readily available, or be the most practical to install. Whatever the case, a facility set must be chosen to satisfy the overall requirement for each facility and utility type identified earlier. Table 2.5 depicts various facility sets capable of satisfying the typical facility requirements used in our example. Once all facility sets have been identified, the data should be reviewed once again with the command section to ensure anticipated mission needs are being met and facility

scopes are satisfactory. When approved by the command section, the package can then be used to identify WRM equipage requirements, perform construction cost estimates, and accomplish initial site layout.

2.4.8. The combat air base planning process provides a credible omnibus package of facility and utility requirements and is particularly viable when several options including construction are available for satisfying facility needs over extended periods. In a true bare base situation where mobile facility assets are the only option initially, facility scopes are essentially predetermined by the number of assets made available in the deployment packages. Nevertheless, the planning process still provides answers to questions involving such items as dispersal, hardening, base defense, CCD, backup utility support, additive mobile facility needs, and recovery equipment requirements.

Table 2.4. Adjusted Requirements Determination.					
FACILITY DESCRIPT.	PLANNING FACTOR	BASIC REQUIREMENT	PRINCIPLES APPLIED	EFFECT	ADJUSTED REQ'TS.
Squadron Ops	9,000 SF/TFS	18,000 SF	Protect Resources Redundancy Accessibility Reliability Plan for People	Revetments Siting CCD Backup Power Air Cond/Vent Dispersal	18,000 SF Backup Power Revetments CCD
Aircraft Revet	1/Ftr Acft	36 ea.	Protect Resources	N/A	36 Revet Kits 438,000 SF AM-2
Elect Power	2.7 kW/Per	5940 kW	Redundancy Resiliency Sustainability Interoperability Protect Resources Reliability	Backup Power Protection On-Site Fuel Storage Dispersal Revet/CCD Fencing/Berm	Generators Revetments 10K Gal Bladders Concertina Wire CCD
Troop Hsg	50 SF/Per	110,000 SF	Plan for People Protect Resources	Siting Air Cond. Dispersal Revetment	110,000 SF Revetments
Base Operations	5,055 SF/AB	5,055 SF	Protect Resources Reliability	Revetment Backup Power CCD	5,055 SF Generator Revetments

Table 2.5. Facility Set Determination.						
FACILITY DESCRIPT.	PLANNING FACTOR	BASIC REQ'T.	PRINCIPLES APPLIED	EFFECT	ADJUSTED REQ'TS.	FACILITY SETS
Squadron Ops	9,000 SF/TFS	18,000 SF	Protect Resources Redundancy Accessibility Reliability Plan for People	Revetments Siting CCD Backup Power Air Cond/Vent Dispersal	18,000 SF Backup Power Revetments CCD	Exist Facilities (13,000 SF) Temper Tent (5,000 SF) Revetment Kit Camo Net Generators
Aircraft Revet	1/Ftr Acft	36 ea.	Protect Resources	N/A	36 Revet Kits 438,000 SF AM-2	B-1 Revet Kits AM-2 Matting
Elect Power	2.7 kW/Per	5940 kW	Redundancy Resiliency Sustainability Interoperability Protect Resources Reliability	Backup Power Protection On-Site Fuel Storage Dispersal Revet/CCD Fencing/Berm	Generators Revetments 10K Gal Bladders Concertina Wire CCD	Exist Facilities 9-750 kW Gen Revetment Kits Bladders Concertina Wire Camo Net
Troop Hsg	50 SF/Per	110,000 SF	Plan for People Protect Resources	Siting Air Cond. Dispersal Revetment	110,000 SF Revetments	Exist Facilities (60,000 SF) Temper Tent (50,000 SF) Revetment Kits
Base Operations	5,055 SF/AB	5,055 SF	Protect Resources Reliability	Revetment Backup Power CCD	5,055 SF Generator Revetments	Exist Facilities Generator Revetment Kit

Chapter 3

FOUNDATION TO BARE BASE PLANNING



3.1. Introduction. As with a building, the bare base planning process requires a foundation upon which the plan can be built. In this case the foundation consists of key assumptions and planning guidelines. An assumption is a statement accepted or supposed true without proof or demonstration. Bare base assumptions were made in order to provide a common point for discussion. Detailed planning might, in some situations, prove some of these assumptions wrong. A planning guideline, on the other hand, is a combination of Joint Chiefs of Staff (JCS) planning factors, Air Staff guidance, results of combat air base planning studies, technical information obtained from a myriad of publications, and field experience. The planning guidelines presented in this chapter are, for the most part, expressed in quantifiable requirements which allow you, the planner, to determine the type and amount of resources necessary to establish your bare base. Additionally, these planning guidelines represent the distilled essence of the subjects treated in greater detail in successive chapters of this volume.

3.2. Assumptions. The following basic assumptions were made in order to provide a common departure point for conducting planning. The following items are generally considered valid for a bare base situation.

- 3.2.1. The bare base scenario is a major regional conflict (MRC).
- 3.2.2. Some areas in the MRC will be subject to hostile fire, while others will not.
- 3.2.3. An adequate runway, parking apron, and taxiway exist to support the assigned mission and aircraft.
- 3.2.4. Bare base operations must be capable of receiving and launching tactical aircraft within 72 hours of employment.
- 3.2.5. Airlift and equipment availability at the site of employment will not be major limiting factors.
- 3.2.6. Bare base medical field units will be located on-base and will require base support services.
- 3.2.7. Deploying forces will arrive per Time-Phased Force and Deployment List (TPFDL).
- 3.2.8. Construction requirements beyond the charter of Prime BEEF combat support forces will be accomplished by RED HORSE, Navy Seabees, Army Engineers or military construction projects. For further details on Prime BEEF and RED HORSE capabilities, see AFI 10-209, *RED HORSE Program*, and AFI 10-210, *Prime Base Engineer Emergency Force (BEEF) Program*.
- 3.2.9. Individual organizations will erect their own tents and shelters with limited technical guidance from civil engineer personnel. Technically complex facilities will be erected by RED HORSE engineers or personnel from the 49th Material Maintenance Group.
- 3.2.10. A water source which can be made potable is available within two miles of the base.
- 3.2.11. Engineer personnel are trained in the erection and installation of bare base mobile assets.

3.3. Bare Base Force Deployment Planning Guidelines. A bare base deployment normally takes place with the phased movement of three distinct forces -- the advance echelon, the initial force, and the follow-on force.

3.3.1. Advance Echelon. The advance echelon or ADVON team should be the first element to arrive at the bare base location. This team should be totally independent and multi-disciplined with both operational and logistical personnel represented. The team includes a combat control element, an engineer site survey team with equipment and vehicles, mobile communications with weather element and 49th Material Maintenance Group personnel as required. Security police elements with vehicles will also be included if the base is in a hostile area. The ADVON team develops the base layout plan; sets up command, control, and communications; installs NAVAIDS; and establishes an aerial port function that will off-load the initial force and its hardware when they arrive. Once the ADVON force is satisfied that the bare base location can support the required mission activities, deployment of the initial force can begin.

3.3.2. Initial Force. The initial force contains the first aircraft squadron with limited operations, maintenance, and support functions; mobility equipment; and spares kits. As these people arrive, they will set up their own shelters with the technical assistance of civil engineers. Civil engineers also have the responsibility for installing the above ground utility systems.

3.3.3. Follow-On Force. The follow-on force contains additional aircraft squadrons, and an upgraded maintenance capability including functions such as PMEL, propulsion, environmental, and missile maintenance. Support functions such as security police, supply, vehicle maintenance, and civil engineers are expanded to give the base a full operational capability.

3.4. Bare Base Engineer Force Employment Guidelines. As the deploying engineer personnel arrive at the bare base location, they must be employed in a logical sequence of tasks that will ensure the base is erected in such a way that it can meet its mission requirements during each stage of development. Employment at a bare base involves a two part operation -- the erection and construction portion and the operations and maintenance portion.

3.4.1. Erection and Construction. During the erection and construction portion of beddown operations, the troops need to hit the ground running. There is a lot to do and a short time to do it. Water points must be established, critical facilities must be erected and mission essential generators must be connected to them. Depending on their condition, airfield pavements may need to be repaired. Navigational aids, runway lighting, and aircraft arresting systems may have to be repaired, replaced, or even installed within 72 hours so that aircraft can be received and launched for combat operations. Additionally, site preparation must take place, electrical generation plants must be installed, and water and electrical distribution systems must be laid out above ground as tents and shelters are being erected. After all the utilities have been connected to their facilities, the distribution systems can be buried and passive defense measures can start to take place.

3.4.2. Operations and Maintenance. The operations and maintenance portion of bare base employment is where civil engineer personnel function much as they do at home station performing the tasks required to keep the base operating in a day-to-day mode. However, the distinction between the erection and construction portion ending and the operations and maintenance portion starting is almost impossible to see. Often there is considerable overlap. For example, once the stand-by generators have been connected to their facilities, they start receiving operational and maintenance checks, even though the electrical distribution system is still being installed in other areas of the base.

3.5. Bare Base Asset Deployment Planning Guidelines. Just as the base population is phased into the bare base location, the facility and utility assets required to support the population and aircraft are also predetermined and incrementally flowed. Without this up front planning and asset sequencing, engineers would be faced with plane loads of equipment that would have to be sorted out on the ramp before any meaningful base beddown could be initiated and any realistic expectation of being able to support early combat sorties could be entertained. The deployment packages associated with the primary bare base asset system, Harvest Falcon, consist of a housekeeping set, an industrial operations set, and an initial flightline support set, as well as follow-on flightline packages. When combined, one housekeeping set, one industrial operations set and one initial flightline set support 1,100 people and one aircraft squadron at one location. Each additional aircraft squadron deployed to that location requires one follow-on flightline operations package.

3.5.1. Housekeeping Set. The housekeeping set is the first Harvest Falcon asset package to arrive. This set basically takes care of people needs by constructing the cantonment area that provides housing, feeding, and hygiene facilities for the troops. The housekeeping set facilities are mostly TEMPER tents. These tents are predominately used for troop billeting, and to house shower/shave units, field deployable latrines and field laundries. The Harvest Falcon kitchen is also made up of TEMPER tent construction. The housekeeping set also provides a few additional TEMPER tents to be used as administrative, briefing and mortuary facilities. The housekeeping set also contains a limited number of hard walled shelters. These include three general purpose shelters for general use and one expandable shelter container to be used as a power production plant. As facilities are erected, the utility systems are also laid out and placed in operation. Included in the housekeeping set are utility equipment packages forming the foundation blocks for electrical and water and waste systems. Table 3.1 depicts the major contents of the housekeeping set.

3.5.2. Industrial Operations Set. The second echelon of the Harvest Falcon deployment package is the industrial operations set. This set basically provides those base support facilities that enable the base to take care of itself. During this stage of development, additional TEMPER tents, hardwall shelters and other structures arrive to provide facilities for functions such as civil engineer shops, supply warehousing, vehicle maintenance shops, chapels, and field exchanges. Even though most of the facilities in this set are TEMPER tents, more and more general purpose shelters, expandable shelter containers, and tension fabric structures start to arrive. TEMPER tents are provided for administration, multi-purpose and chaplain facilities, as well as most civil engineer shops. The general purpose shelters are used for civil engineer pavements and equipment and power production shops. The expandable shelter containers are utilized for facilities such as control centers and the tactical field exchange. The frame supported tension fabric structure is a modular structure of between 4,000 and 8,000 square feet that is used for supply, vehicle maintenance, and packing and crating type facilities. These types of shelters are being replaced by dome shelters, and it is likely you will see both types in the field for awhile. Additional utility components to support all these facilities are also included in the industrial set. Table 3.2 lists the primary facilities and utility components contained in the industrial operations set.

3.5.3. Initial Flightline Support Set. The next stage of bare base development involves the installation of the initial flightline support set. This set provides maintenance and operational support facilities with associated utilities for one aircraft squadron. The set contains mostly hardwalled shelters. Numerous expandable shelter containers provide many of the aircraft maintenance shops. General purpose shelters are used for AGE shops and multi-purpose functions such as squadron operations and briefing rooms. Functions requiring large work areas, like a propulsion shop, are housed in tension fabric structure shelters. There are a limited number of TEMPER tents included in this set which support aircrew alert, fire operations, and crash rescue functions. To directly support flying operations, the initial flightline support set also contains airfield lighting and aircraft arresting systems. Table 3.3 shows the major components of the initial flightline support set.

Table 3.1. Harvest Falcon Housekeeping Set (XFBKA).	
ITEM	QUANTITY
ROWPUs,	3
Water Distribution System,	1
Generators, 60-kW MEP-006,	4
Generators, 100-kW MEP-007,	3
Generators, 750-kW MEP-012A,	4
Primary Cable Skids,	4
Secondary Distribution Centers,	20
Power Plant ESC/PDC System,	1
Fuel Bladders, 10,000 Gallon	1
Remote Area Light Sets,	5
Environmental Control Units,	150
TEMPER Tents, Admin,	16
TEMPER Tents, Billeting,	94
TEMPER Tents, Briefing,	2
TEMPER Tents, Laundry,	2
TEMPER Tents, Mortuary,	1
GP Shelters, General Use,	3
Field Latrines & Tents,	6
Shower/Shaves & Tents,	5
9-1 Kitchen,	1
Camo Net/Pole Pallets,	1
Light Carts,	20
Primary Distribution Center (PDC),	1
TEMPER Tents, ,Water Plant	2

Table 3.2. Harvest Falcon Industrial Operations Set (XFBRB).	
ITEM	QUANTITY
Water System, Source Line and Distribution Loop	1
Generator, 750-kW MEP-012A	1
Fuel Bladder, 10,000 Gallon	1
Secondary Distribution Centers	4
Environmental Control Units	42
8000 SF FSTFS, General Use	3
8000 SF FSTFS, Packing and Crating	1
8000 SF FSTFS, Supply	1
4000 SF FSTFS, Vehicle Ops/Maint	2
ESCs, General Use	5
ESCs, Supply	2
ESCs, Tactical Field Exchange	2
GP Shelters, General Use	2
GP Shelters, CE Shops	2
TEMPER Tents, Admin	4
TEMPER Tents, CE Shops	12
TEMPER Tents, Chapel	1
TEMPER Tents, Mortuary	1
TEMPER Tents, Multipurpose	4
TEMPER Tents, Tactical Field Exchange	2
Mobile Kitchen Trailers	2
Latrines with Tents	6

Table 3.3. Harvest Falcon Initial Flightline Support Set (XFBS1).	
ITEM	QUANTITY
Emergency Airfield Lighting System	1
Mobile Aircraft Arresting System	1
BAK-12 Systems (two energy absorbers each)	1
B-1 Revetment Kits	42
Generators, 60-kW MEP-006	2
Secondary Distribution Centers	8
Environmental Control Units	42
TEMPER Tents, Alert Billeting	3
TEMPER Tents, Fire Station	3
8000 SF FSTFS, General Use	1
8000 SF FSTFS, Propulsion Shop	1
4000 SF FSTFS, General Use	2
ESCs, General Use	3
ESC, Avionics	1
ESC, Bearing Cleaning	1

ESC, Electrical Maintenance	1
ESC, Fuels Lab	1
ESC, Life Support	1
ESC, NDI Lab	2
ESC, Parachute Shop	1
ESC, Pneudraulic/Environmental	2
ESC, Aircraft Wheel/Tire Shop	1
GP Shelters, General Use	9
GP Shelters, Power/Non-power AGE	2
Aircraft Hangars	2
Flightline Fire Extinguishers, 150 lb	24
Light Cart	2
Latrines with Tents	2

3.5.4. Follow-On Flightline Operations Package. If additional aircraft squadrons are to be deployed to the bare base location, a supplemental facility set is provided for each added squadron. Called the follow-on flightline operations package, this set contains facilities and utilities that extend the capability of the initial flightline set to support additional aircraft. The follow-on package includes general purpose shelters, expandable shelter containers, an aircraft hanger, and utility system components. Table 3.4 depicts the utility and facility contents of this aircraft follow-on support package.

Table 3.4. Harvest Falcon Follow-On Flightline Operations Set (XFBS2).	
ITEM	QUANTITY
Secondary Distribution Centers	4
Environmental Control Units	12
ESC, Avionics	1
ESC, Life Support	1
ESC, Electrical Maintenance	1
GP Shelter, General Use	1
GP Shelter, Power/Non-power AGE	2
GP Shelter, Propulsion	1
Aircraft Hangar	1
Flightline Fire Extinguishers, 150 lb	18
Latrine with Tent	2

3.5.5. Although the Harvest Falcon and Harvest Eagle asset packages contain many facilities and utility support systems, these assets alone do not satisfy total bare base requirements. A bare base cannot operate in a mission responsive posture using only Falcon and Eagle assets. Several complementary programs exist which engineer personnel must be aware of since some of these programs will require engineer support or directly assist engineer forces in accomplishing bare base taskings. Typical of these other systems and equipment are:

3.5.5.1. Mobile Flightline Maintenance Equipment. For the most part, this equipment represent the powered and non-powered aerospace ground equipment (AGE) used for aircraft maintenance purposes.

3.5.5.2. User Unique Tactical Shelters. Many types of tactical shelters not directly associated with the Harvest Falcon or Eagle packages exist which provide unique facility and utility support for bare base users. The majority of these are aircraft related maintenance shops dedicated to specific types of aircraft.

3.5.5.3. Vehicles. Vehicle packages which provide bare bases with general and special purpose transportation equipment are major support items.

3.5.5.4. Mobile Hospitals/Clinics and Equipment. The medical support facilities and related systems discussed in chapter 11 fall in this category.

3.5.5.5. Communications Equipment. This facilities grouping includes communications equipment such as base communications networks and NAVAID packages.

3.5.5.6. Civil Engineer Heavy Equipment. Typical of this category would be rapid runway repair vehicle additives (R-sets) to the base vehicle fleet.

3.5.5.7. Other Functional Area Unique Equipment. Included in this grouping are a myriad of equipment items which individually may not be major, but in total, represent a considerable weight and cube requirement for airlift movement.

3.6. Engineer Planning Guidelines. The following guidelines reflect planning criteria for various major bare base facility and utility requirement areas.

3.6.1. Airfield.

3.6.1.1. If installed aircraft arresting barriers are operational and adequate in number, they will require operational checks and maintenance. When inoperative, or where none exist, mobile aircraft arresting systems (MAAS) must be provided.

3.6.1.2. As a minimum, runway edge and approach lights are required.

3.6.1.3. Navigation aids (NAVAIDs) are required. Installation will be accomplished jointly by communications and civil engineer personnel.

3.6.1.4. An aircraft parking plan is required.

3.6.1.5. Aircraft revetments (Republic type B-1), when required, will be constructed 16-feet high on ramps, aprons, matting, or hardstands.

3.6.1.6. If additive aircraft parking surfaces are required to support surge, dispersal, or overcrowding conditions, stabilized areas will be required. If available, AM-2 matting should be the primary material considered.

3.6.2. Site Layout.

3.6.2.1. The site should be relatively flat terrain with minimal grading, brush, or tree removal required.

3.6.2.2. Blasting or large rock removal should not be required.

3.6.2.3. Major soil stabilization work should not be required.

3.6.2.4. The site will require surveying to establish base lines, major functional areas, and specific areas using field expedient survey methods, when possible.

3.6.2.5. Whenever health, safety, or environmental factors exist, base layout distances will be those recommended in Volume 6 of this manual series. Under conditions other than those mentioned above, the distances are minimized to improve functional relationships and to save on utility system costs.

3.6.2.6. Petroleum, oil and lubricants (POL) site preparation consists of siting, grading, berming, and furnishing and installing a 3-inch dike drain pipe with gate valve. All fuel bladders, regardless of size and content, will be bermed; all fuel bladder dikes will be fitted with a protective liner to prevent environmental damage and contamination. Bladders, headers, adapters, fill stands, and R-14 units with associated attachments will be furnished and installed by base supply fuels operations personnel.

3.6.2.7. The munitions storage site preparation consists of siting, grading, berming, and sandbagging. Construction of storage bunkers should begin as soon as possible after other more essential tasks are completed. In the interim period, munitions should be stored in temporary bermed sandbagged areas if sandbags are available. Also, plan on providing a grounding system for the munitions area consisting of ground rods and connecting grid system.

3.6.2.8. Medical unit site preparation consists of siting and grading approximately 0.8 acre for the 50-bed Air Transportable Hospital (ATH), 4.9 acres for the 250-bed Contingency Hospital (CH), and 2.1 acres for the 250-bed Aeromedical Staging Facility (ASF). Medical units should be sited in lower threat areas of the base but near combat support group services facilities (billeting, showers, laundry).

3.6.2.9. Civil engineer personnel will site and locate all facility groups and will site, locate, and erect all utility plants and systems.

3.6.3. Facilities.

3.6.3.1. Civil engineers will erect their own facilities and will furnish a minimum cadre of personnel to provide technical assistance to other base functions erecting their own facilities.

3.6.3.2. The emergency troop housing planning factor of 50 sq. ft. per person will be used for the bare base. Soft-walled shelters will be used for personnel billeting.

3.6.3.3. Allowance Standard (AS) 158, Harvest Falcon, is used to determine base support shelter requirements. If Harvest Eagle assets are being considered for use, AS 159 is the allowance source document.

3.6.4. Electrical Power.

3.6.4.1. Power requirements will be based on 1.5 kW per person for the cantonment area (housekeeping). When an industrial capability is added, the planning factor increases to 2.7 kW per person. Additive power requirements are necessary for every 50-bed ATH (200 kW), 250-bed CH (1300 kW), and 250-bed ASF (250 kW).

3.6.4.2. The 750-kW diesel generator will provide a net continuous electrical power output of 750 kW at 60 cycle frequency and 625 kW at 50 cycles when environmental conditions do not exceed 100 degrees Fahrenheit at 5,000 feet.

3.6.4.3. An additional generator is added to the total generator requirements in the housekeeping package to allow generator rotation and periodic maintenance. This brings the total up four generators in the housekeeping package.

3.6.4.4. Even though centrally located high voltage generators offer the most advantageous primary distribution system, they should be dispersed in a high threat area between prime and slave power plant locations to improve survivability. Multiple power plants and primary distribution loops that interconnect these plants are especially critical in high threat locations. If a power plant becomes inoperative for any reason, the electrical grid can be energized from the remaining power plant(s).

3.6.4.5. Mission essential power (MEP) generators (60 kW-100 kW) should be dispersed throughout the base to satisfy initial power requirements for priority facilities until the base electrical distribution system (750-kW units) becomes fully operational. At that time, the MEPs will become a backup source of mission essential power for critical base functions.

3.6.4.6. Remote area lighting (RAL) should be installed around POL, liquid oxygen (LOX), flight lines, medical units, and munitions storage. Primary and secondary distribution systems should be extended to these areas to provide power for RAL units.

3.6.4.7. Since the total connected load will not be operating continuously, a diversification factor of seven-tenths (0.7) should be applied to all loads except air conditioning or unique loads which require full demand at all times.

3.6.4.8. When practical, electrical distribution cables can be placed in the same trench as water or sewage pipes. However, when camp layout, topography, or health considerations dictate otherwise, separate trenches for all utilities must be used.

3.6.5. Water.

3.6.5.1. Water treatment plants must be installed at base sites where water is nondrinkable. The Reverse Osmosis Water Purification Unit (ROWPU) is required for water desalinization, removal of suspended solids from fresh water, and chlorination control of bacteria.

3.6.5.2. Total water allocation is 20 gallons per person per day (gpd) at locations where mobile assets (ROWPUs and associated distribution systems) are solely used. When a permanent, in-place water treatment and production capability is available at a beddown location, a 50 gpd factor may be used. Additive water requirements are necessary for each 50-bed ATH (5,500 gal/day), 250-bed CH (22,000 gal/day), and 250-day ASF (12,000 gal/day).

3.6.5.3. ROWPU water production is relative to the parts per million (ppm) of dissolved solids content in the raw water source. For seawater purification where the salt content usually exceeds 35,000 ppm, the 600 gallon per hour (gph) ROWPU is derated to 400-450 gph. The 1,100-person Harvest Falcon housekeeping set contains three ROWPUs for water production under normal conditions.

3.6.5.4. A five-day minimum water storage capability is required using 20,000-gallon bladders. For planning purposes, 60 percent of the stored water should be treated water and 40 percent should be untreated water. Untreated water is used for fighting fires, washing laundry, aircraft, and vehicles (except raw water with high salt content), controlling dust, construction purposes, and improving electrical grounds. The Harvest Falcon housekeeping set contains six 20,000-gallon water storage bladders. If demineralized water is also required, an additional bladder must be provided.

3.6.5.5. If available, one chilled water fountain will be provided for approximately every 65 people. Due to the limited number available, chillers should be allocated to areas with the greater population densities such as the flightline, base operations, cantonment area and similar functional groups. Additionally, three chilled water fountains are required for each ATH (one in each ward and one in outpatient area), 13 for each 250-bed CH (one per ward and three in outpatient areas), and seven for each 250-bed ASF (dispersed in patient areas). These requirements are based on a chilled water fountain that produces 15 gph of 60 degree Fahrenheit water when the input water temperature is 120 degrees Fahrenheit. Chilled water fountains should be strategically located in shower/latrine and functional areas where water is already available. Water lines should not be run to functional areas for the sole purpose of providing drinking water. Chilled water fountains must be of the type with a downward water flow, allowing drinking containers to be filled without excessive waste.

3.6.5.6. One 400-gallon water trailer is required for every 400 people. The Harvest Falcon housekeeping set includes three water trailers. Additionally, one water trailer is required for each 50-bed ATH and 250-bed ASF, and three for each 250-bed CH.

3.6.5.7. Minimal non-dining hall ice requirements are 4.4 pounds per person per day. Ice machine(s) will be located at water treatment plant(s). The transportable blood transshipment center (TBTC) requires 800 pounds of ice per day.

3.6.5.8. In Southwest Asia (SWA), temperatures range from a daytime high of 130 degrees Fahrenheit to a nighttime low of 30 degrees Fahrenheit. Where possible, pipes should be buried to a depth of 18 inches or more to provide mechanical protection to the system and to prevent heat gain from high ambient temperatures.

3.6.5.9. Demineralized water is required in support of flying and medical operations. The type and mixes of tactical and strategic aircraft will determine the required quantity. A five-day minimum water storage capability is required for demineralized water where exact quantities are known. However, when requirements for demineralized water exist but exact quantities are unknown, allow one 20,000-gallon bladder for this purpose.

3.6.5.10. Where total dissolved solids content of water used for showers and laundry exceeds 500 ppm, DOD/Navy-type "salt water use" soaps and detergents should be used.

3.6.6. Waste Disposal.

3.6.6.1. Approximately 70 percent of all potable water (14 gpd in arid climates) is assumed to become wastewater that enters the sewer system for treatment at wastewater lagoons. The remaining 30 percent of potable water will be lost through leaks, perspiration, evaporation, and food preparation.

3.6.6.2. When modular latrine units (field deployable latrine system) are to be used, the sanitary system treatment facilities should be sized to accept all human waste. When the field deployable latrine is used without piped sewage disposal, latrine holding tanks must be emptied periodically and the human waste transported to wastewater lagoons. The Harvest Falcon housekeeping set contains a minimum of four deployable latrines; each latrine set has twelve toilets and two urinal troughs.

3.6.6.3. Depending upon the salinity of the raw water source, for every gallon of potable water produced by ROWPUs, up to two gallons of brine water can be produced. Provisions for the disposal of brine water must be made. If possible, brine water should be returned to the source. The lagoons discussed later in this manual have not been sized to accept brine water, since the salt content of the brine water would upset biological treatment and evaporation processes.

3.6.6.4. Biodegradable soaps, paper, and detergents should be used in an effort to eliminate unnecessary wastewater problems.

3.6.6.5. A combination of gravity flow and a force main sewer system is part of the Harvest Falcon waste distribution system. Grinders are used in the force main portion of the sewage system ahead of lift pumps to grind waste material to a slurry thereby reducing the power requirements and workload of the pumps.

3.6.6.6. Solid wastes from dining halls should be buried or incinerated. A kitchen usually produces one half to one pound of garbage per person per day. Kitchen grease traps should be maintained daily by services personnel and inspected weekly by civil engineer personnel.

3.6.6.7. Biological waste (the disposition of human body parts) requires that an incineration site be established in a remote area of the base. Where incineration is not possible, a pit about 4 to 6 feet deep (depending on the water table) should be used to bury biological remains.

3.6.7. Fuels.

3.6.7.1. One 10,000-gallon fuel bladder should be provided for every two 750-kW diesel generators collocated at power plants.

3.6.7.2. At full load each 750-kW diesel generator consumes approximately 40 gph of fuel.

3.6.7.3. At full load each 100-kW MEP generator consumes about 6 gph of diesel fuel and each 60-kW unit about 4 gph.

3.6.7.4. MEP generators are normally fueled by internal tanks. Base supply fuels personnel are responsible for central storage and resupply of fuel for MEP generators.

3.7. Task Priorities. To establish a bare base operation within the desired time limits and at a fully mission capable level, many engineering tasks must be completed. Some tasks can be performed concurrently, others sequentially, and some may be dependent on bare base asset flow and availability. A recommended order for bare base tasking accomplishment is provided below.

3.7.1. Priority 1 Taskings.

3.7.1.1. Runway Preparation. Consists of inspection, cleaning, and striping of runways, as required. Also includes placement of appropriate markers, e.g., distance-to-go signs.

- 3.7.1.2. Runway Edge and Approach Lights. Required when night combat operations are necessary or a sustained logistics buildup is needed. Runway edge lights must be installed by nightfall of day one.
- 3.7.1.3. Navigational Aid Sites. Involves site preparation to position NAVAIDs on clear and level surfaces.
- 3.7.1.4. Mobile Aircraft Arresting System (MAAS). Installation of a MAAS where permanent or expedient aircraft arresting systems are inoperable or nonexistent.
- 3.7.1.5. Emergency Pavement Repairs. A runway condition survey determines the scope of this task. Other considerations may include early expansion requirements and threat of attack.
- 3.7.1.6. Water Point. Requires clearance of an access route to a water point or source when installation of the water system is blocked by obstructions.
- 3.7.1.7. Water Treatment Plant(s). Installation of water plants so that potable water is available.
- 3.7.1.8. Functional Groups and Facilities. The location of functional groups and facilities is marked by survey stakes or other expedient marking devices.
- 3.7.1.9. Water Distribution System. Installation of pipes, pumps, and storage tanks. Also includes installation of fill stands for firefighting and domestic fill points.
- 3.7.1.10. Mission Essential Power. Installation of MEP generators to provide temporary power to mission essential functions.
- 3.7.1.11. Primary Power. Installation and operation of the primary generation and distribution system.
- 3.7.1.12. Latrines. Requires establishment of expedient latrine facilities or erection of field deployable units.
- 3.7.1.13. Dining Hall. Provision of electrical power and water to food service facilities, and construction of flooring.
- 3.7.1.14. Control Center. Erection of the civil engineer shelter by personnel not performing other Priority 1 tasks.
- 3.7.1.15. Medical Treatment Facilities. Assistance provided for erection of medical shelters (when requirement exceeds medical unit's organic capabilities), and connection of medical facilities to base utility systems.
- 3.7.1.16. Fire Protection. Provision of fire protection, crash rescue, and minimal first aid services.
- 3.7.1.17. Warning System/Giant Voice Systems. Installation and operation of base alerting systems.
- 3.7.1.18. Unexploded Ordnance. A survey of the complete beddown area must be performed for presence of surface and subsurface unexploded ordnance.
- 3.7.2. Priority 2 Taskings.
 - 3.7.2.1. Airfield Clear Zones. Removal of major obstructions that endanger safe landing, taxiing, and takeoff.
 - 3.7.2.2. Aircraft Ramps and Aprons. Sweeping, cleaning, and repair of aircraft ramps and parking areas.
 - 3.7.2.3. POL Storage. Leveling of fuel bladder sites and construction of protective earth berms and dikes.
 - 3.7.2.4. Aircraft Arresting Systems. Operational check of these systems prior to the arrival of fighter aircraft.
 - 3.7.2.5. Ammunition Storage. Site clearance, leveling and start of berm construction in preparation for arrival of munitions.
 - 3.7.2.6. Static Grounds. Installation of static grounds and tie-downs at fueling points, munition arm and dearm pads, hot cargo (munitions and hazardous materials) off-loading pads, and parking areas.
 - 3.7.2.7. Showers. Installation of personnel showers and temporary Wastewater drains.
 - 3.7.2.8. Facilities. Erection of engineer shops and billets, and provision of technical guidance for shelter erection to other base functions, using personnel not assigned to Priority 1 work.
 - 3.7.2.9. Expedient Runway Repair. Accomplishment of expedient runway repairs to the extent required by the runway condition.
 - 3.7.2.10. Expedient Aircraft Ramp Extensions. Construction of additional aircraft pavements, ramps, and aprons, when required, must be started early to prevent delay of logistics buildup. Expeditionary paving materials, such as AM-2 or fiberglass matting, are used.
 - 3.7.2.11. Aircraft Revetments. Construction of revetments for the protection of tactical and strategic aircraft.
 - 3.7.2.12. Security Fences and Anti-Vehicular Obstacles. Construction and installation of perimeter and access way security features.
 - 3.7.2.13. Entomology. Provision of entomological services to rid an installation of pests and maintain a sanitary environment under austere conditions.
 - 3.7.2.14. Environmental Quality and Control/Disposal of Hazardous Materials. Cleanup of hazardous materials found upon arrival at an installation and proper control of any such materials generated during base buildup and operation.
- 3.7.3. Priority 3 Taskings.
 - 3.7.3.1. Electrical Service. Extension of electrical service to all base facilities; installation of MEP generators in emergency backup power modes.

3.7.3.2. Base Roads. A continuing task that must be expedited to permit an unimpeded flow of facilities and logistic materials from the off-load ramp to the buildup sites.

3.7.3.3. Sanitary Fill. Construction of trenches and burn pits for the disposal of solid wastes.

3.7.3.4. Wastewater Lagoons. Construction of Wastewater lagoons when required by environmental conditions.

3.7.3.5. Sewage Collection Systems. Installation of pipes, sump pumps, lift stations, and other components of the sewage collection system; provision of bare base site drainage; and connection of showers and latrines to the sewage collection system.

3.7.3.6. Flooring. Construction of flooring for non-critical facilities which was omitted during initial erection of these shelters.

3.7.3.7. Grease Pits, Septic Tanks, and Leaching Fields. Construction of grease traps at kitchens and required shops; installation of septic tanks and leaching fields for facilities that required Wastewater disposal but are not tied into the sewage collection system.

3.7.3.8. Washrack. Construction of washrack to meet aircraft maintenance requirements.

3.7.3.9. Facility Hardening. Use of expedient methods (sandbags, protective earth berms, revetments, digging-in) to harden critical facilities.

3.7.3.10. Camouflage, Concealment and Deception (CCD). Application of CCD measures to counter the enemy threat.

3.7.3.11. Decoys. Assembly, placement, and maintenance of decoys.

3.7.3.12. Air Base Defense (ABD). Construction of defensive positions for the ABD force when threat conditions dictate their preparation as a Priority 3 task.

3.7.3.13. Emergency Disposal Range. Preparation of a land area to be used by EOD for munitions destruction.

3.7.4. Priority 4 Taskings.

3.7.4.1. Operations and Maintenance. The continuation of other tasks, as needed, to include operation and maintenance of bare base and existing facilities, utilities, roads, pavements, and similar bare base priorities.

3.7.4.2. Contingency Response Plans. Development and update of contingency plans to include base recovery after attack and natural disaster responses.

3.7.4.3. Training. The training and rehearsal of contingency tasks which should include security measures, base recovery, and base denial.

3.7.4.4. Quality of Life Improvements. Provision, as time permits, of improvements to facilities and utilities such as increased square footage, more access points, hot water, air conditioning, etc.

3.7.4.5. Recreation Support. Construction of basic recreational facilities and fields and supplying utilities to these facilities as necessary.

3.7.4.6. Resource Accountability. Establishment of controls over materials, equipment and vehicles to preclude loss, damage or unauthorized use. Includes inventory, assignment of responsibility, and provision of protective features such as fencing, shelters, lighting, etc.

3.8. Climate and Weather.

3.8.1. Worldwide Considerations. Planning guidelines for the effects of climate and weather vary with the location of the bare base. For example, close to the equator all seasons are nearly alike, with rain throughout the year. Farther from the equator, in areas such as Central America and Southeast Asia, there are distinct wet (monsoon) and dry seasons. Both regions have high temperatures, heavy rainfall, and high humidity. All these climatic phenomena impact on bare base operations in the tropics. Conversely, the common characteristic of all desert areas is their aridity. No rainfall has been recorded in the Atacama desert in Chile, for example, for several years, but rain does fall in deserts. Rain, when it does occur, may consist of one single violent storm in a year with high surface water run-off which, from a planning perspective, makes such rainfall a liability rather than an asset. While each climatic region confronts the bare base planner with its unique problems, none is quite as problematic as the arid desert environment. Extremely high daytime heat combines with near freezing temperatures at night (in the inland Sinai desert, for example, day to night temperature can fluctuate as much as 72 degrees Fahrenheit), imposing an unusual strain on bare base personnel and equipment. Consequently, climatic planning guidelines for the arid Southwest Asian environment receive prominent treatment in the following paragraphs of this chapter; the effects of climate and weather on bare bases located in other climatic zones are discussed throughout this volume.

3.8.2. Southwest Asia.

3.8.2.1. Since SWA receives very little rain, precipitation is not considered as a significant factor. But as was mentioned earlier, sudden and intense rains occurring as much as several hundred miles away may cause flash flooding in another distant location. Construction in areas where there is a likelihood of ponding should be avoided. A thorough terrain analysis should reveal natural drainage swales subject to flash flooding.

3.8.2.2. Winds in SWA can achieve almost hurricane force and dust and sand suspended within them can make life almost intolerable, any type of activity very difficult, and restrict visibility to a few yards. Strong winds are invariably followed by rapid changes in temperature.

3.8.2.3. Burial of utility lines, and shading of fuel bladders, generators, and vehicles will be required to reduce the effects of intense sunlight emitted from a cloudless sky.

3.9. Manpower.

3.9.1. There are two distinct phases of employment during a bare base operation: the erection and construction phase, and the operation and maintenance phase. The first phase is more manpower intensive than the second. The number of civil engineer personnel required during the erection and construction phase will not change radically at the lower populations because the tasks of preparing taxiways and runways, installing runway lights, constructing POL and ammunition areas, and installing utility systems remain relatively constant regardless of base population.

3.9.2. The maximum manpower requirement for electrical, utilities, and engineering personnel will exist during the erection and construction phase of the force beddown. Maximum manpower requirements for power production and heating/air conditioning personnel will exist during the longer term operation and maintenance phase of the deployment. During the initial erection and construction phase of the deployment, technicians in pest control, force management, liquid fuels maintenance, and structures can be used to assist electrical, utilities, and engineering crews to erect civil engineer facilities and utilities. Additionally, specially trained personnel from any of these Air Force Specialties (AFSs) can be used to supervise other crews of base personnel in erection of base facilities.

3.9.3. Although this publication makes no allowances for temperature extremes in its time and labor estimates, each bare base location imposes its own set of constraints which translate into "additives." Allowances must be made for acclimatization, reduced working hours during extreme heat or intense cold, and the difficulties of handling materials under severe climatic conditions. Again, the arid desert environment imposes the worst set of working conditions and is therefore singled out for recommendation of the following guidelines (guidance for manpower planning in less demanding climates is given in chapter 13).

3.9.3.1. A period of approximately two weeks should be allowed for acclimatization, with progressive degrees of heat exposure and physical exertion.

3.9.3.2. When it is not possible for combat and combat support forces to become fully acclimatized before being required to perform heavy labor, personnel should work in shifts, strenuous work should be reduced during the hottest part of the day or limited to the cooler hours, and personnel should be allowed to rest more frequently than normal.

3.9.3.3. The prevention of heat injuries, generally considered an individual responsibility in most situations, becomes a matter of command concern in an environment that is especially harsh to the inexperienced. Proper wear of clothing (loose-fitting, allowing plenty of ventilation), periodic intake of water, frequent rest breaks, and any other measure necessary to preserve the warfighting capability of personnel are critical factors.

3.10. Heating, Ventilation, and Air Conditioning.

3.10.1. Heating should be provided in all personnel shelters, used for detail work or occupied for extended periods of time, to maintain an interior dry bulb temperature above 50 degrees Fahrenheit. Within permanent and semipermanent facilities, an effective temperature of 65 degrees Fahrenheit should be maintained, unless dictated otherwise by workload or extremely heavy clothing. Heating systems should be installed when possible, so that hot air is not discharged directly on personnel.

3.10.2. A minimum of 20 cubic feet of air per minute of outside air per person should be introduced into any personnel enclosure to provide adequate ventilation. Air should be circulated within the space to prevent stratification or stagnation and delivered within the occupied zone (past a person) at a velocity less than 100 feet per minute. Under nuclear, biological or chemical (NBC) conditions, ventilation requirements should be modified as required. Ventilation or other protective measures must be provided to keep gases, vapors, dust, and fumes within safe limits. Intakes for ventilation systems must be located to minimize the introduction of engine exhaust emissions or similar sources of contaminated air.

3.10.3. Air conditioning has been designed for use in all facilities except storage and those with little or no occupancy. Utility systems are designed to accept a total air conditioning package. When air conditioning is installed, it should be done so that cold air is not discharged directly on personnel.

3.10.4. Humidity should be approximately 30-65 percent at 70 degrees Fahrenheit. Humidity should decrease with rising temperatures, but should remain above 15 percent to prevent irritation and drying of the eyes, skin, and respiratory tract. It is also important that the temperature of enclosed areas be held relatively uniform. The temperature at floor level and at head level should not differ by more than 10 degrees Fahrenheit.

3.11. Noise Suppression and Lighting.

3.11.1. Personnel should be protected from noise levels which cause injury, interfere with voice or any other communications, cause fatigue, or in any other way degrade overall effectiveness. Equipment such as diesel generators, which generate noise in excess of maximum allowable levels, should be placed a sufficient distance away from facilities where people work or billet so as not to cause personnel injury. If sufficient distance cannot be achieved, noise barriers or baffles should be installed. Concrete "Bitburg" revetments have proven to be effective in this regard. Workspace noise should be reduced to levels that permit necessary person-to-person and telephone communications and establish an acceptable acoustical work environment.

3.11.2. Where equipment is to be used in enclosures and is not subject to blackout or special low level lighting requirements, illumination should be distributed to reduce glare and reflection. Adequate illumination should be provided for maintenance tasks. General and supplementary lighting should be used, as appropriate, to ensure that illumination is compatible with each task situation. Portable lights should be provided for personnel performing visual tasks in areas where fixed illumination is not provided.

3.12. Transportation. Special and general purpose vehicles will be required to erect the bare base assets and to improve and maintain the bare base site. Bare base equipment brought into an installation by airlift will normally be offloaded onto a cargo holding apron by aerial port personnel. Transportation personnel are responsible for moving cargo from the ramp to the point of use. Due to a limited number of vehicles, joint usage of vehicles by transportation and civil engineers may be required. A coordinated effort between engineers and transportation is necessary during movement and placement at the use location of bare base facilities, utilities, and support items. To meet operational deadlines, engineer forces should be prepared to move bare base assets from the apron holding area to sites of intended use without assistance from other organizations.

3.13. Medical Facilities Support.

3.13.1. Initial bare base medical support will normally be provided by an Air Transportable Clinic (ATC). ATCs will usually support populations up to 1,100, particularly when local medical support is unavailable. More than one ATC may be deployed to some bare base sites to provide adequate medical treatment. The ATC must attain operational capability within 24 hours after employment.

3.13.2. The 50-bed Air Transportable Hospital (ATH) supports populations of 3,000 or more. The ATH is normally deployed in increments beginning with a 14-bed ATH called Coronet Bandage, increasing to a 25-bed ATH, and finally reaching full capability at the 50-bed ATH. The 14-bed ATH or 25-bed ATH will support populations up to 3,000. More than one ATH may be deployed to some bare base sites to provide adequate medical support. The 14-bed, 25-bed, and 50-bed ATH must attain operational capability within 24 hours after employment.

3.13.3. The 250-bed Contingency Hospital (CH) will be regionally located at selected bare base aerial port locations to treat patients received from throughout a theater of operation. The CH must become operational within 7 days of employment.

3.13.4. The 250-bed Aeromedical Staging Facility (ASF), when deployed, will be collocated with the 250-bed CH. The 250-bed ASF must attain operational capability within three days after employment.

3.13.5. Transportable Blood Transshipment Centers (TBTC) will be collocated with the 250-bed CH.

3.14. Nuclear, Biological, and Chemical (NBC) Warfare. The threat of NBC weapons being used against a bare base, either during or after its construction, is ever present. Decontamination procedures and siting of decontamination stations must be determined by civil engineer readiness personnel. Provisions must be made for the disposal of contaminated water from the decontamination processes. This publication presents no specific planning guidelines for NBC warfare; however, AFMAN 32-4005, *Personnel Protection and Attack Actions*, addresses this area. The impact of NBC warfare on bare base operations should be considered in the BCE Contingency Response Plan and during training exercises.

3.15. Camouflage, Concealment, and Deception (CCD).

3.15.1. The fact that the bare base exists will be difficult to conceal from the enemy. CCD planning, therefore, must concentrate on decreasing the range of target acquisition by delaying recognition of targets and by concealing or decoying valuable bare base assets, thus making precision bombing difficult. Forestalling the bomb release of high speed aircraft by as little as one second causes a delivery error of several hundred yards and could prevent target destruction.

3.15.2. Planning for CCD should be coordinated with bare base construction planning from the outset; it is much easier and less costly in time, manpower, and camouflage materials to apply camouflage during the setup phase than to add camouflage as an after-the-fact effort. Early planning for camouflage increases the awareness in all personnel and helps eliminate unnecessary ground and terrain disturbances which would otherwise defeat the purpose of camouflage or require additional effort to conceal the disturbance.

3.15.3. Where natural cover and concealment is inadequate or absent, the standard camouflage net system (SCNS) will be used as an aid in the concealment of bare base assets. When camouflage nets are to be used, net requirements are calculated based on priorities set by the commander, the resources available, and the planner's decision on which items are to be camouflaged with nets.

3.15.4. Recognizing that camouflaging all the assets on the bare base with nets would be logistically difficult to support, the planner must make every effort to reduce net requirements by taking maximum advantage of the terrain (in terms of natural concealment), by clustering several facilities or equipment items together and erecting a net over the entire group, or by placing nets only on the side of structures which contain the shadow.

3.15.5. Coordinated CCD planning will require compromises between the need for camouflage and dispersion, the efficiency of access, the maintenance of security, the allocation of scarce resources, and a number of similar considerations that depend upon aspects unique to each bare base location and its mission. Details relating to the use of CCD methods and types of materials available can be found in volume 2 of this publication series.

3.16. Security, Air Base Defense, and Antiterrorism.

3.16.1. In the accomplishment of its bare base mission, civil engineers rely upon security police forces to shield and extricate their personnel from hostile action. In some situations (during the early stages of a deployment, for example), availability of security police forces may be very limited. In such a situation, engineer personnel must rely upon their individual weapons, flack vests, hardened vehicles, cover and concealment, and protective positions to provide for their own security and survivability.

3.16.2. For the bare base planner, civil engineer involvement in air base defense (ABD) should be anticipated in these areas: design and construction of defensive fighting positions, vehicle fighting positions, and entry control points; removal of foliage around critical resources (to establish clear zones); assistance in establishing sector command posts and the base defense operations center (to include electrical power hook-up); establishment of an armory and other storage facilities; and assistance in setting up sensor equipment and mounting thermal imagers. In addition, the bare base planner should anticipate, when ordered to do so by the base or wing commander, the integration of the engineer unit into the ABD force to defend against enemy threats to the bare base.

3.16.3. The threat of terrorist activity directed against our forces must be assumed to exist at any time and anywhere a bare base is being established. In addition to the obvious requirement for an enhanced security posture of the civil engineer force, the bare base planner must be prepared to support base-wide antiterrorism measures. As the only unit on base with the capability to create the physical means that deter or impede a terrorist intrusion, civil engineers must be prepared to fabricate, install, or emplace a variety of barriers, obstacles, and fortifications. Volume 2 of the publication series contains instructions and guidance on how to support these types of construction efforts and participate as a member of the ABD force.

3.17. Base Recovery and Denial. Bare base development and growth are evolutionary processes. Early efforts are concerned with the flying mission and protection of the base's inhabitants from the elements. As the base grows, more emphasis must be placed on contingency training and planning to include base recovery and base denial. From a base recovery aspect, serious up front thought should be given to such wartime related features as equipment and material dispersal locations, accessways for response vehicles, personnel shelter locations, communication capability between facilities, utility system redundancy, and facility dispersal and hardening. Base denial planning should consider not only the more common tactic of asset destruction, but also, and perhaps more importantly, address the removal and transport of bare base assets away from the land battle area. Even though these initiatives come later in the bare base development cycle, they require early planning to ensure air base survivability, and that materials and equipment are available, when required.

3.18. Asset Reconstitution. At the conclusion of a bare base deployment the mobility assets used are normally placed back into storage to await future requirements and taskings. Oftentimes this part of the bare base operation doesn't receive the proper degree of attention. A key step in this retrograde process is the refurbishment and reconstitution of the assets that have been worn out or damaged over the course of the deployment. The 49th Material Maintenance Group (MMG) has the primary responsibility for repair and maintenance of Harvest Eagle and some Harvest Falcon mobility assets. At the end of contingency deployments this organization normally receives these assets back at storage locations and subsequently proceeds to conduct item inventories, identify component shortages, repair damaged or worn items, and repackage assets for storage. This reconstitution process is involved and time consuming since hundreds, if not thousands, of individual assets must be handled. To speed up this process and help prolong the product life of mobility assets, several actions should be taken by all facility users and, in particular, engineer personnel.

- 3.18.1. Disassembly. Disassembly and tear down of mobile facility and utility assets should be carefully and properly accomplished. Follow technical order instructions and guidance provided by people who are familiar with the assets.
- 3.18.2. Inventory. Identify those pieces or items that are missing, broken, or non-functional and ensure a written list of these deficiencies is included with the asset being redeployed.
- 3.18.3. Cleaning. Ensure the asset is as clean as possible and free from any foreign material that might cause damage or contamination during shipment. Keep in mind that aircraft and customs inspections will have to be passed.
- 3.18.4. Packaging. Take care to properly put the asset in its shipping configuration or package the asset correctly in its shipping container. Again, follow technical order instructions and the advice of those people who know what to do. Make sure the deficiency list mentioned above is included in the shipping container or firmly attached to the asset itself if a container is not used.

CHAPTER 4

BARE BASE SITING AND CONSTRUCTION GUIDELINES



4.1. Introduction. For a bare base to withstand a harsh environment and to keep occupants reasonably comfortable, the location of a facility or utility should be determined by analyzing the constraints and features of the area. Overall siting analysis should include the climatic constraints of solar radiation, temperature, precipitation, and prevailing wind. It should also include natural features of the ground surfaces, such as topography, ground cover, and drainage patterns. Follow-on construction, especially during the early stages of bare base erection, should be initiated so that the primary concerns are preparation of the airfield for its operational mission, establishment of water treatment plants, and beddown and protection of the inhabitants from the elements. As the bare base develops and its operational mission is assured, more emphasis can then be placed on creature comfort items and base support functions such as administrative offices, personnel, finance, and dining facilities. In order to ensure wise and prudent use of civil engineer manpower during the first 72 hours of employment, work priorities and schedules should be established. It is in this way that a limited civil engineer combat support force can accomplish all the job tasks expected and still ensure that aircraft are launched on schedule. This chapter starts with a discussion of the basic principles involved in proper site selection. It then gives general criteria behind the conceptual plans developed for this volume, and then provides construction tips for consideration during the erection phase of bare base development.

4.2. Site Selection. The siting of new facilities at a bare base is influenced by the topography and climatic conditions, by the principle of grouping related facilities to improve efficiency and by the contrary principle of dispersing facilities to limit damage from enemy attack. Facility hardening and camouflage, concealment, and deception also increase protection from attack. Site specific planning guidelines which take into account the many variables in topography and weather for the major climatic regions of the world are presented in chapter 12. However, without some sort of master bare base plan, facility siting tends to follow the pattern of existing roads and facilities. This may work out fine in some situations, but an overall plan which zones the base into functional areas with room for expansion can help achieve orderly growth, operational efficiency, and also conserve scarce resources.

4.3. Bare Base Plans. The plans presented in this volume - by and large - were developed around functional relationships. Dispersal patterns and groupings are minimized to every extent possible. In general, this conceptual plan is designed around a relatively flat terrain with no effort to anticipate extremes in elevations, topography, washes, gullies, rocks, or other unusual site conditions. Perhaps the approach is too idealistic. But, assuming some degree of engineering competence from you, the planner, site specific drawings can take each of these extremes under consideration. A word of caution, however, changes to this volume should be considered only for the most compelling reasons (i.e., mission, threat, terrain, etc.) because deviations sometimes drive unwarranted and unprogrammed utilities, manpower, and materials. Overall, these plans were developed using dispersed planning factors and a hypothetical mix of aircraft for the different base populations (see table 4.1). As alluded to earlier, when distance between facility groupings appeared excessive for the smaller base populations and when health and safety factors were not involved, these distance factors were modified.

Table 4.1. Population Levels with Typical Aircraft Mix.	
BASE POPULATION	ASSUMED MIX OF AIRCRAFT
1100	18 TAC
1950 - 2200	36 TAC
2800 - 3300	36 TAC 12 STRAT/CARGO or 54 TAC
3650 - 4400	54 TAC 12 STRAT/CARGO or 72 TAC

4.4. Distances.

4.4.1. Distances used in developing these plans are generally those recommended for dispersed layout in volume 6 of this publication series, Planning and Design of Contingency Air Bases. Functional area spacing and shelter spacing are shown in tables 4.2 and 4.3. Keep in mind the distances listed are the recommended minimums for survivability yet the maximum distances desired with respect to utility system layouts. Some of the distances were reduced to conserve the utility system assets, and others were reduced to minimize communal distances between functional areas. For example, group headquarters and supply were moved closer to the flightline. In some cases, recommended 1,500 foot spacings were reduced to 1,000 feet.

4.4.2. Distances for nondispersed layouts between functional areas and shelters are shown in tables 4.4 and 4.5, respectively.

4.4.3. Because of time constraints, it may be necessary to circumvent conventional survey techniques for more expedient field methods. For example, distances can be determined by tape measure, by "pacing off," or even by vehicle odometer readings. Conventional survey techniques should be used only when time is not a factor or where accurate horizontal or vertical measurements are mandatory.

4.5. Plans Orientation. North arrows shown in this publication are for orientation purposes only and are not necessarily true geographical north. Should actual north and this publication's north coincide, it is purely coincidental. Facility orientation is by rows and columns. However, staggering and irregular locations are recommended in order to maximize passive defense

within the limitations of the utility systems. The same principle applies to the different area locations. Use extreme caution in staggering to avoid infringement upon utility routings. Latitude and longitude should also be considered in orienting facilities in order to minimize shadows, solar radiation, and winds.

4.6. Construction Sequence. In general, bare base facilities and utilities should be constructed in the following sequence (for priority of the different construction jobs, see chapter 3, Task Priorities); however, many of these tasks can be accomplished simultaneously.

4.6.1. Runway preparation (sweeping, painting, etc.).

4.6.2. Runway edge and approach lights.

4.6.3. Water treatment plants.

4.6.4. Emergency essential power.

4.6.5. Sanitary latrine facilities (expedient).

4.6.6. Direct operational support functions.

Table 4.2. Dispersed Distances (feet). Facility Group Areas

FACILITY GROUP	B - BILLETING	C - CHAPEL	DA - SERVICES	DB - SERVICES	DC - SERVICES	E - ENGINEER	F - MAINTENANCE	G - FLYING SQ OPS	H - SUPT GP	I - BASE OPS/ FIRE DEPT	J - AERIAL PORT	L - LAUNDRY	M - MUNITIONS	O - LOX	P - POL	R - ALERT	S - SUPPLY	T - TRANSPORTATION	W - WING HQ	X - HOSPITAL	Y - COMM.
B - BILLETING	150	200	200	200	200	1500	1500	800	200	1500	1500	200	3150	1500	2840	1000	1500	900	200	200	200
C - CHAPEL	200		200	200	200	1500	1500	1500	200	1500	1500	200	3150	1500	2840	1500	1500	1500	200	200	200
DA - SERVICES	200	200		200	200	200	200	200	200	200	200	200	3150	1500	2840	200	200	200	200	200	200
DB - SERVICES	200	200	200		200	200	200	200	200	200	200	200	3150	1500	2840	200	200	200	200	200	200
DC - SERVICES	200	200	200	200		200	200	200	200	200	200	200	3150	1500	2840	200	200	200	200	200	200
E - ENGINEER	1500	1500	200	200	200		200	200	1500	1500	1500	200	3150	1500	2840	200	1500	200	1500	1500	200
F - MAINTENANCE	1500	1500	200	200	200	200		200	800	1000	1500	200	3150	1500	2840	200	1500	200	1500	1500	200
G - FLYING SQ OPS	800	1500	200	200	200	200	200	200	1500	200	1500	200	3150	1500	2840	200	1500	200	1500	1500	1500
H - SUPT GP	200	200	200	200	200	1500	800	1500		700	1500	200	3150	1500	2840	1500	900	1500	200	200	200
I - BASE OPS/FIRE DEPT	1500	1500	200	200	200	1500	1000	1500	700		200	200	3150	1500	2840	1500	800	1500	1500	1500	200
J - AERIAL PORT	1500	1500	200	200	200	1500	1500	1500	1500	200		200	3150	1500	2840	1500	200	1500	1500	1500	200
L - LAUNDRY	200	200	200	200	200	200	200	200	200	200	200		3150	1500	2840	200	200	200	200	1500	200
M - MUNITIONS	3150	3150	3150	3150	3150	3150	3150	3150	3150	3150	3150	3150		3150	1800	3150	3150	3150	3150	3150	3150
O - LOX	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	3150		2840	1500	1500	1500	1500	1500	1500
P - POL	2840	2840	2840	2840	2840	2840	2840	2840	2840	2840	2840	2840	1800	2840		2840	2840	2840	2840	2840	2840
R - ALERT	1000	1500	200	200	200	200	200	200	1500	200	1500	200	3150	1500	2840	200	1500	200	1500	1500	1500
S - SUPPLY	1500	1500	200	200	200	1500	1500	1500	800	800	200	200	3150	1500	2840	1500		1500	900	1400	200
T - TRANSPORTATION	900	1500	200	200	200	200	200	200	1500	1500	1500	200	3150	1500	2840	200	1500		1500	1500	200
W - WING HQ	200	200	200	200	200	1500	1500	1500	200	1500	1500	200	3150	1500	2840	1500	900	1500		200	200
X - HOSPITAL	200	200	200	200	200	1500	1500	1500	200	1500	1500	1500	3150	1500	2840	1500	1400	1500	200		200
Y - COMM.	200	200	200	200	200	200	200	200	200	200	200	200	3150	1500	2840	200	200	200	200	200	

Table 4.3. Dispersal Distances - Individual Facilities.	
FACILITY GROUP	DISTANCE BETWEEN INDIVIDUAL FACILITIES (SHELTERS ONLY)
All groups except Billeting and Munitions	60 feet
Billeting	150 feet between billet groups (25, 26 or 27 billets each group); 12 feet between billets in a row (6 or 7 billets each row); 60 feet between rows (4 rows each group); 60 feet minimum between latrines and billets.
Munitions	Facility spacing within munitions storage area will be in accordance with chapter 5, AFMAN 91-201.
See special notes 1 and 2	1. Distance indicated can be increased/decreased by 10% in any direction to obtain irregular or staggered layout and to take advantage of natural cover and concealment. 2. Walk-in refrigerators are not considered as shelters; kitchen, dining hall and dry storage/food preparation shelters are considered as one facility (for spacing) when erected.

Table 4.4. Facility Group Areas - Nondispersed.				
FACILITY GROUP	ALL AREAS EXCEPT LOX, MUNITIONS & POL (feet)	LOX (feet)	MUNITIONS* (feet)	POL (feet)
All areas except LOX, Munitions, and POL.	150 **	1500	3150	2640
LOX	1500		3150	2640
Munitions*	3150	3150		1800
POL	2640	2640	1800	

* Based on 250,000 pounds of explosives (not barricaded)

** Example: Distance between areas F (Maintenance) & D (Services) is 150 feet.

Table 4.5. Individual Facilities - Nondispersed.	
FACILITY GROUP	DISTANCE BETWEEN INDIVIDUAL FACILITIES
All groups except Billeting and Munitions	30 feet
Billeting	60 feet between billet groups (25, 26 or 27 billets each group) 12 feet between billets in a row (6 or 7 billets each row) 30 feet between rows (4 rows each group) 60 feet minimum between latrines and billets
Munitions	Facility spacing within munitions area will be in accordance with chapter 5, AFMAN 91-201

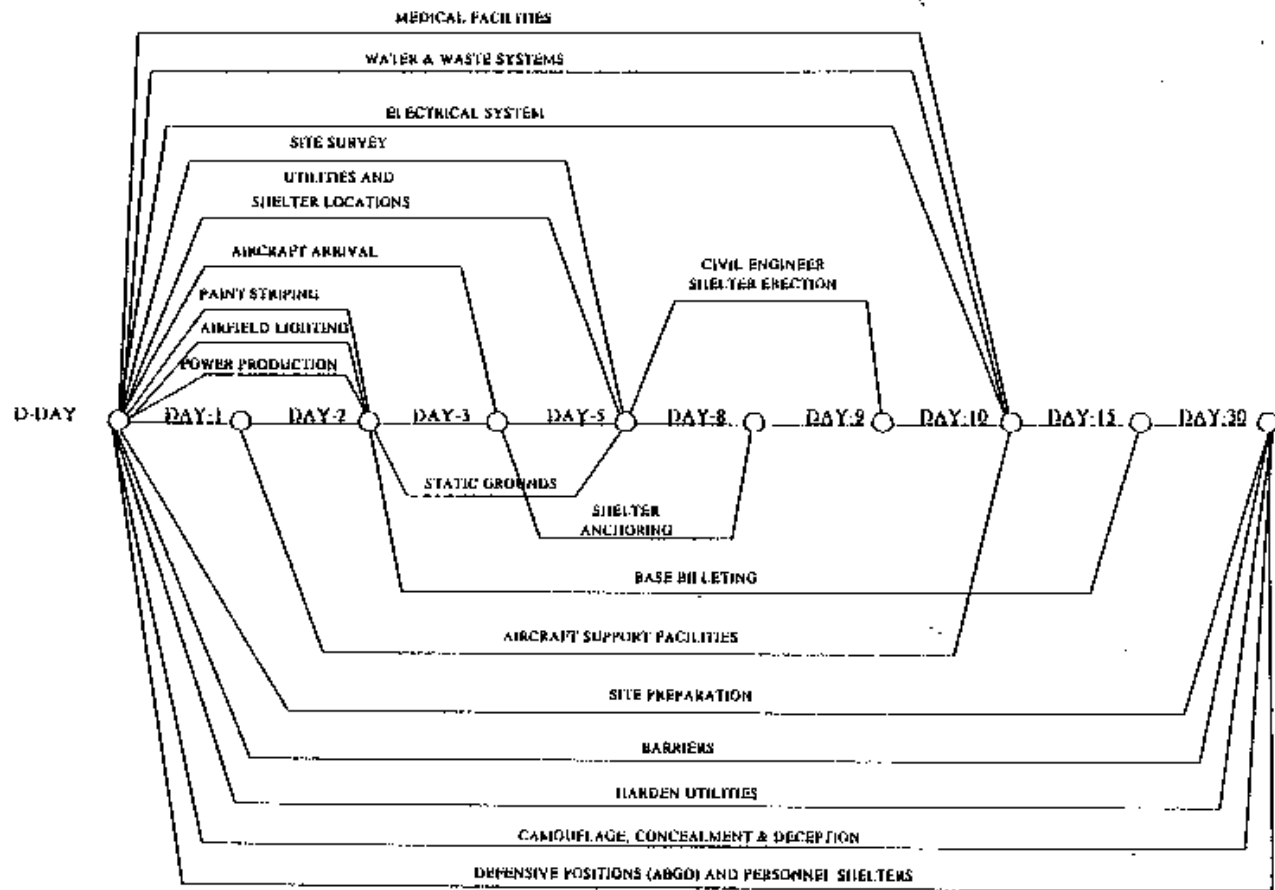
- 4.6.7. Aircraft maintenance operational support functions.
- 4.6.8. Temporary munitions storage.
- 4.6.9. Petroleum, oil, lubricants (POL) systems.
- 4.6.10. Medical treatment facilities.
- 4.6.11. Decontamination facilities.
- 4.6.12. Electrical distribution system.
- 4.6.13. Water distribution system.
- 4.6.14. Indirect operational support facilities (kitchen, dining hall, etc.).
- 4.6.15. Waste utility systems.
- 4.6.16. General billeting.
- 4.6.17. Camouflage, concealment, and deception, and personnel shelters.
- 4.6.18. Recreation.

4.7. Construction Schedule. Table 4.6 is a list of major tasks to be accomplished during base erection. This list is not intended to be all inclusive, but to serve merely as a guideline, for you, the planner. A critical path method diagram of a typical erection and construction schedule based on a 30-day effort is found in figure 4.1. This schedule is predicated on launching the first aircraft within 72 hours after arrival at the bare base. There could be situations that would require altering this construction schedule so this deadline can be met. This 72 hour requirement does not imply that the base will be completed but that the minimum requirements of the runway, taxiway, water, communications, barriers, turn-around capability, fueling and arming capabilities, and parking ramp are available. It is important to note that the construction schedule diagram does not reflect the phases of operation when installing the utility systems. For example, before the main generating plants and primary distribution cables are installed, it is necessary to hook up the mission essential power (MEP) generators, secondary cables and secondary distribution centers (SDC) relevant to providing mission essential power to all direct operational support requirements. Once this is complete, the remaining elements of the electrical distribution system can be constructed. The same approach applies to the water and waste utility systems. In other words, the water treatment and storage tanks are established before distribution lines are laid, and operational latrines are constructed ahead of the waste disposal system.

Table 4.6. Construction Schedule.		
MAJOR TASK	TIME (D + X) REQUIREMENT	DEFINITION
SITE SURVEY	1-5 Days	Develop Harvest Falcon/Eagle assets, locate NAVAIDS and lay out base.
SITE PREPARATION	1-10 Days	Clear land, establish access to raw water, construct roads, establish drainage, construct POL and munitions revetments.
AIRFIELD LIGHTING	D + 2 Days	Set up Emergency Airfield Lighting System (EALS).
BARRIERS	D + 30 Days	Maintain aircraft barriers.
UTILITY LINES AND SHELTER LOCATIONS	D + 5 Days	Stake facility locations.
ELECTRICAL DISTRIBUTION	D + 10 Days	Install high voltage cables, connect PDC & SDC, provide electric power to shelters.
POWER PRODUCTION	D + 2 Days	Set up 750-kW generators.
WATER TREATMENT & DISTRIBUTION	D + 10 Days	Lay water lines, develop water and waste program.
CIVIL ENGINEER SHELTERS	4 Days	Erect CE shops, office, billets; provide technical assistance.

STATIC GROUNDS	4 Days	Locate/establish static grounds.
PAINT STRIPING	D + 2 Days	Mark taxiways and runways.

Figure 4.1. Critical Path Method Diagram - Base Development



Chapter 5

AIRFIELD REQUIREMENTS



5.1. Introduction. The airfield is defined, for the purpose of this pamphlet, as that part of the bare base that is devoted to the operation of aircraft. A typical airfield consists of runways, taxiways, hardstands, aprons, and other airfield pavements, navigational aids, aircraft arresting barriers, airfield lighting and marking, overruns, and approach zones. However, the prerequisites for a bare base airfield demand only a usable runway, taxiway, and parking area. Supporting areas such as aircraft parking aprons, arm and disarm pads, hot cargo off-loading pad, aircraft turn-around points, and taxiways may require construction, modification, or upgrading to meet Air Force standards and mission requirements.

5.2. Overview. Working on the assumption that the bare base airfield just meets its basic prerequisite, this chapter will help you tailor the airfield to meet the operational requirements of the types of aircraft that will be using it. Specifically, this chapter describes the essential features of a runway, lists dimensions of aircraft and associated runway clearance requirements, and then addresses the equipment and facilities needed to make the runway operational.

5.3. Bare Base Mission. It is critical for you to first determine the numbers and types of aircraft assigned, identify all available aircraft parking areas, and determine turn-around requirements (servicing, refueling, and rearming). It is important to remember that even though many missions may be built around tactical aircraft, some or most of the bare base supplies will be airlifted in by transport planes. The airfield requirements must be geared toward airlift aircraft as well as tactical aircraft and, in some cases, strategic aircraft. The ability of the bare base to accept, park, and turn-around these aircraft must be evaluated as soon as possible. Limiting factors must be identified and transmitted to higher headquarters to enable them to schedule only those aircraft that can properly land and carry out their mission. The data derived from the airfield evaluation also serve as the basis for any rehabilitation or upgrade effort required to make the bare base fully mission capable.

5.4. Runway Requirements. The essential features of a runway are its length; clearances, both on the ground and in the surrounding airspace; and surface condition. Required pavement strength is also important and is a function of aircraft type, weight, and the amount of traffic expected. (See table 5.1 for aircraft classification numbers (ACN) for various types of aircraft.) Although a normal landing or takeoff may use only part of the runway, pilots need length and clearance to recover safely from emergencies. In addition to the minimum runway lengths given in table 5.2 (Aircraft Data), up to 1,000 feet of paved or compacted overrun should be provided at each end of the runway. Beginning at each end of the runway is a large rectangular clear zone (figure 5.1). The end clear zones include the overruns. Ideally, these clear zones should not contain any tree stumps, raised slabs, steep ditches or similar objects that would present a hazard to an out-of-control aircraft. The far end of the clear zone marks the ground contact of the approach/departure clearance surface. This theoretical surface forms

the "floor" of the glide path. It rises at a gradual slope from both ends of the runway, extending for several miles. No tree, utility pole, water tower, or elevated terrain feature should penetrate the approach/departure surface. Dimensions for overrun, end clear zone, and approach/departure surface are shown in table 5.3. Lateral clearance dimensions are also shown in this table. Lateral runway clearances are important safety features when aircraft encounter control problems or strong crosswind conditions. First is the shoulder, which should always slope away from the runway. While generally paved at permanent bases, runway shoulders at bare bases should at least be dust stabilized. Extending out from the shoulders on both sides of the runway is the lateral clear zone, an area graded similar to the end clear zones. Taxiing aircraft, crash rescue vehicles, aircraft arresting systems, and navigational aids may be allowed in the lateral clear zone. The lateral safety zone is an imaginary surface which starts from the ground at the edge of the lateral clear zone and rises up and out at a 7 to 1 slope. Terrain and vegetation must not pose a hazard in this area. The lateral safety zone extends out to the runway lateral clearance distance, which is the closest (table 5.3) that you may plan to locate structure and other fixed objects to the runway center line. Lastly, runway surface condition could eventually affect sustained flight operations. Assumed usable during initial bare base operations, surfaces must be monitored and repaired as necessary to support continued sortie production.

5.5. Taxiway Requirements. Taxiways require lateral clearance but no end clearances unless they serve as emergency runways. Lateral taxiway clearances consist of 10-foot shoulders, paved or dust stabilized, and a lateral clear zone extending 65 feet (75 feet for C-141s) from the shoulder to any fixed or mobile obstructions.

Table 5.1. Aircraft Classification Number (ACN).							
AIRCRAFT	WEIGHT	RIGID PAVEMENT SUBGRADE STRENGTH			FLEXIBLE PAVEMENT SUBGRADE STRENGTH		
		HIGH	MED	LOW	HIGH	MED	LOW
B-1	189,000	14	16	20	11	12	11
	480,000	68	80	92	32	28	23
B-52	230,000	19	23	28	23	25	30
	488,000	103	116	128	94	101	114
FB-111	57,500	15	16	16	18	20	21
	114,300	56	56	55	59	58	57
C-5	375,000	8	10	11	10	13	17
	772,000	29	32	39	37	43	54
C-9	70,000	12	14	15	12	14	16
	108,000	29	31	33	27	30	34
C-17	331,400	11	13	15	13	16	20
	580,000	43	44	47	47	53	64
C-130	70,000	8	9	11	6	8	11
	175,000	34	37	41	30	34	37
KC-135	140,000	7	8	9	7	8	11
	322,500	37	45	54	37	45	54
C-141	144,500	25	30	35	27	32	38
	345,000	48	58	68	51	58	70
KC-10	270,800	12	13	15	14	17	21
	593,000	48	57	68	58	64	75
E-3	186,900	16	18	22	15	19	23
	325,000	38	46	55	38	45	54
RF-4	35,900	10	10	11	11	12	12
	58,000	26	26	25	27	26	26
A-10	28,000	8	8	8	8	9	9
	50,000	21	21	21	20	20	20
F-16	16,900	6	6	6	6	6	6
	35,400	15	15	15	14	14	14
F-15A/B	32,100	11	11	11	11	11	12
	68,000	28	27	27	26	25	24
F-15E	33,400	11	11	11	11	11	12
	81,000	37	37	37	35	33	33
747	358,200	17	19	22	19	20	22
	750,000	42	49	59	46	51	62
F-111	59,600	16	17	17	19	21	22
	98,900	45	45	45	48	47	47

Table 5.2. Aircraft Data.

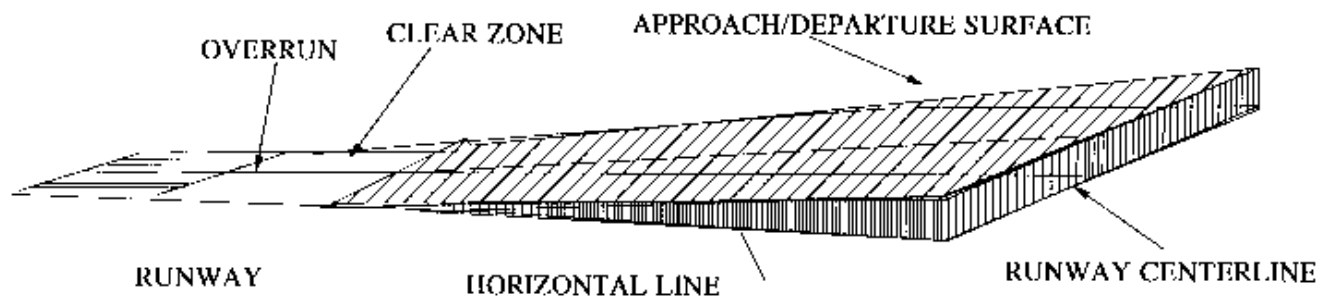
AIRCRAFT	WING SPAN (FT)	LENGTH (FT)	HEIGHT (FT)	TRACK ¹ (FT)	WING TIP SEPARATION (FT)	WEIGHT		TGR ² (FT)	MINIMUM RUNWAY	
						Empty	Max T.O.		Rear Area	Support Area
B-1	136.7	150.7	33.6	14.5	25	189,000	480,000	10,200	N/A	N/A
B-52	185.0	156.6	40.8	8.3	25	230,000	480,000	7,450	N/A	N/A
FB-111	70.0	75.5	17.1	10.0	10	57,500	114,300	6,200	N/A	N/A
C-5	222.7	247.8	65.1	36.0	50	375,000	772,000	10,000	N/A	N/A
C-9	93.4	119.3	27.5	16.4	25	70,000	108,000	4,600	N/A	N/A
C-17	170.0	175.2	55.1	25.0	50	331,400	580,000	7,600	10,000	6,000
C-130	132.6	99.5	38.5	14.3	25	70,000	175,000	4,100	6,000	3,500
KC-135	130.8	136.2	41.7	22.1	50	140,000	322,500	8,700	10,000	N/A
C-141	160.0	168.4	39.3	17.5	25	144,500	345,000	5,900	10,000	6,000
KC-10	165.3	182.1	58.1	35.0	50	270,800	593,000	9,000	10,400	N/A
E-3	145.7	152.9	42.2	22.1	50	186,900	325,000	6,540	10,000	N/A
RF-4	38.4	63.0	16.5	17.9	10	35,900	58,000	4,000	8,000	6,000
A-10	57.5	53.3	14.9	17.2	10	28,000	50,000	5,000	8,000	6,000
F-16	32.8	47.6	16.4	7.8	10	16,900	35,400	2,700	8,000	6,000
F-15A/B	42.8	63.8	19.2	8.9	10	32,100	68,000	2,600	8,000	6,000
F-15E	42.8	63.8	19.2	9.0	10	33,400	81,000	4,000	8,000	6,000
747	195.7	231.8	64.7	36.1	50	358,200	750,000	11,000	11,000	N/A
F-117	43.4	65.1	12.4		10	30,000	52,500			
F-111	63.0	73.5	17.0	10.0	10	59,600	98,900	5,400	8,000	N/A
F-22	44.4	62.1	16.6	10.6	10					
B2	172.6	69.5	16.9	40.3	10					

NOTES:
¹ Width of landing gear.

² Take-off ground run at sea level, 59°F.

Table 5.3. Minimum Runway Clearance Requirements.					
RUNWAY CLEARANCE SUPPORT AREA AIRFIELD	CONTROLLING AIRCRAFT				REMARKS
	F-15 (Feet)	C-130 (Feet)	C-141 (Feet)	C-17 (Feet)	
OVERRUN					
Length	300	300	500	300	Same width as runway
Width	72	72	150	90	
END CLEAR ZONE					
Length	500	500	500	500	Begins 500' from threshold
Width	700	700	700	700	
APPROACH/DEPARTURE SURFACE					
Length	32,000	10,500	32,000	10,500	Width from runway edge
Inner Width	700	700	700	700	
Width @ 10,000'L	2,000	2,500	2,500	2,500	
Outer Width	2,500	2,500	2,500	2,500	
Glide Slope	35:1	35:1	50:1	20:1	
SHOULDER	10	10	10	20	Width from shoulder
LATERAL CLEAR ZONE	35	35	100	100	
RUNWAY LATERAL CLEARANCE DISTANCE	350	350	350	350	

Figure 5.1. Clear Zone.



5.6. Apron Requirements. There are no standard sizes for aprons. They are individually designed to support specific aircraft and mission at specific installations. The detailed dimensions are determined by the size, type, and number of aircraft requiring parking and maneuvering space and by the type of activity the apron serves. For bare base planning purposes, use the dimensions given in table 5.2 on aircraft size and wing tip separations as the basis for determining apron requirements. Begin with 100 percent of the assigned aircraft as established by official operations plans (OPLANs); from this subtract any aircraft that are located on separate aprons, such as alert aircraft; also subtract the aircraft that are normally located in maintenance hangars under maintenance schedules; finally, subtract any aircraft that are parked elsewhere on existing paving or hardstands. After determining the types and numbers of aircraft with apron requirements, determine individual apron requirements by multiplying the wingspan of the selected aircraft by its length. If the selected aircraft is a fighter type or FB-111 aircraft, multiply this product by a factor of 4.4; if strategic or cargo aircraft, use a factor of 3.5. The total apron requirement is merely the numerical sum of all the separate apron requirements. A rough estimate of the area needed for each helicopter is derived by multiplying its operating length by its operating width (table 5.4) and then multiplying this product by a factor of 9.2.

Table 5.4. Helicopter Dimensions.		
HELICOPTER	WIDTH	LENGTH
CH/HH-53 B/C	72.3	88.3
CH/HH-3E	62.0	73.0
HH-1H	48.3	57.1
UH-1N	48.0	57.3
UH/TH-1F/P	48.0	57.1
UH-60A	53.7	64.9
Helicopter dimensions are operating dimensions.		

5.7. Airfield Lights. If installation of an airfield lighting system is required, there are both Harvest Eagle and Harvest Falcon portable airfield light sets that can be installed by contingency forces.

5.7.1. Harvest Eagle Airfield Lighting Kit. A Harvest Eagle airfield lighting set is a 6.6-amp high intensity lighting system that can provide threshold and runway edge lighting for up to 9,000 feet of bare base runway. The Harvest Eagle lighting set does not include approach lights, strobe lights, barrier marker lights, distance marker lights, or any sort of lighted visual glide path indicators.

5.7.1.1. Harvest Eagle Lighting System Components. The Harvest Eagle lighting system components are essentially the same as those found in a rapid runway repair (RRR) set. The major difference is the quantity of cable, light fixtures, and transformers contained in the RRR set as opposed to the Harvest Eagle set. It should be noted that components of both kits are not only highly reliable, but are also identical to airfield lighting systems used at military and civilian airports throughout most of the world. In the event of a deployment to a bare base where the airfield lighting is inoperative, the Harvest Eagle or RRR kit can be used to repair the existing systems or, if damaged beyond repair, to set up a completely independent system. Major components of the Harvest Eagle airfield lighting kit are:

5.7.1.1.1. Light Mounts. This metal stake is designed to be driven into the ground to support a type C-1 runway light fixture. Metal cones are also used as mounts for runway edge light fixtures.

5.7.1.1.2. Cable Assembly. This is a 205-foot, #8 AWG, single conductor segment with a precast rubber plug with male connection on one end and female connection on the other end. If these precut cables are not included, then they will have to be made from a reel of airfield lighting cable and joy splice kits.

5.7.1.1.3. Colored Lenses. Green and red lens filters are included for use in setting up the threshold lights.

5.7.1.1.4. Light Fixtures. The C-1 runway light fixture is used for edge and threshold lighting by changing bulbs and lens filters.

5.7.1.1.5. Lamps. Clear lens lamp assemblies (edge lights) use 200-watt, 6.6-amp, T-10 clear bulbs; threshold light assemblies use 45-watt bulbs.

5.7.1.1.6. Transformers. This item is required for use with each lamp assembly for isolating the lamp circuit from the series feeder circuit.

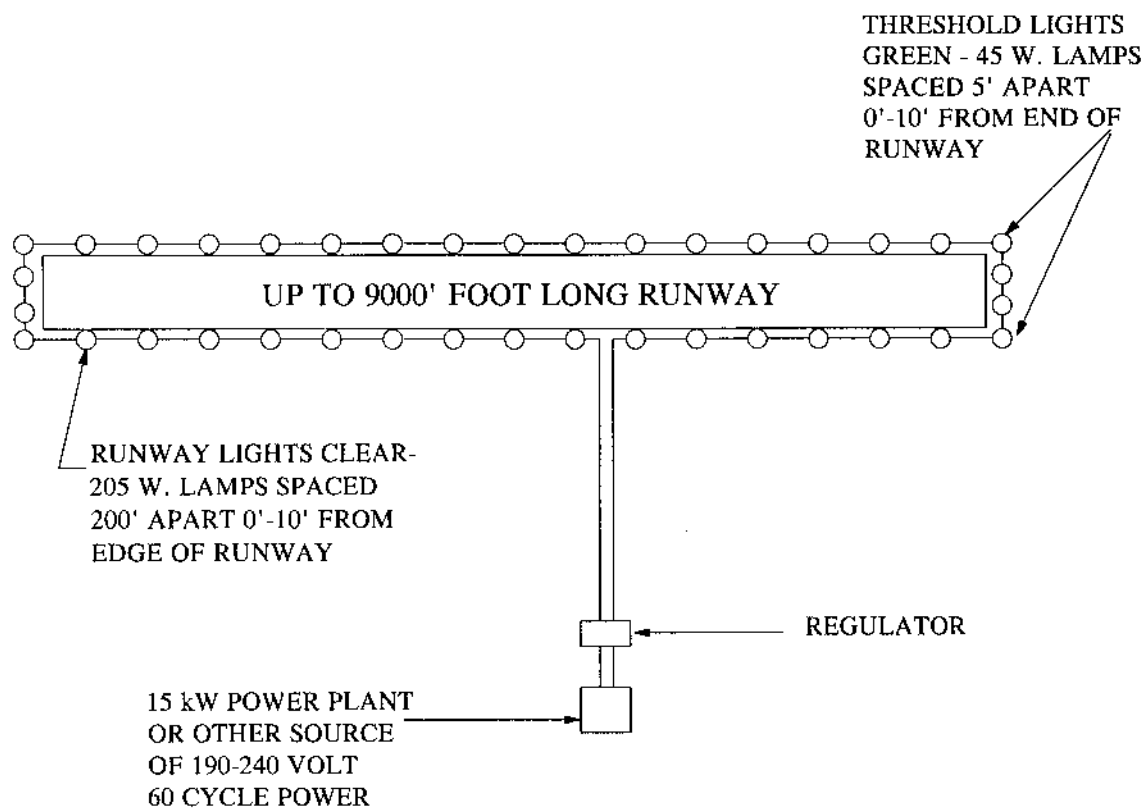
5.7.1.1.7. Regulator, Type C-3. This regulator has a 240-volt primary, with a 15-kW constant current designed to regulate the intensity of the runway lights within the desired range from minimum to maximum. The lights can be controlled from the regulator via a 5-step switch that can increase output amperage from 1.1 amps in stages to the highest setting of 6.6 amps.

5.7.1.1.8. Power Source. Two 60-kW generators are provided as part of the lighting set to permit an immediate operational capability. If a power grid is eventually installed or local base power is deemed reliable, the airfield lighting can be connected to these sources and the 60-kW generators relegated to backup mode.

5.7.1.1.9. Emergency Bean Bag Lights. These portable lights are powered by 6-volt batteries. Similar to a flashlight, the unit is manually turned on and placed alongside the emergency landing or minimum operating strip (MOS) at intervals of up to 200 feet.

5.7.1.2. Harvest Eagle Airfield Lighting Installation. The runway lighting circuits should be laid out approximately as shown in figure 5.2 using Harvest Eagle airfield lighting components. Runway edge lights should be installed along both sides of the runway at intervals no greater than 200 feet. Each pair of lights, one on each side of the runway, should be placed as nearly as possible opposite each other. The two rows of lights should be located 4 to 10 feet off the edge of the runway. The threshold lights should be spaced five feet apart and no further than 10 feet from the end of the runway. The color of the lights and their position relative to the runway or MOS are also shown in figure 5.2. The regulators and supporting generators should be installed in an advantageous location, but sufficient distance (about 750 feet) from the runway so as not to constitute an obstruction for aircraft. More detailed installation instructions are found in volume 3 of this pamphlet series. A four-person crew is normally used for Harvest Eagle airfield lighting installation.

Figure 5.2. Harvest Eagle Airfield Lighting Layout.



5.7.2. Emergency Airfield Lighting Set (EALS). Included in the Harvest Falcon package is a recently developed airfield lighting system called the emergency airfield lighting set. It can be used to support runway surfaces up to 150 feet by 10,000 feet and can be installed and secured on all types of surfaces, e.g., sand, frozen earth, mud, ice, asphalt, and concrete. Packaged on six trailers, the system is air transportable fitting within the space of four C-130 pallet positions. The system includes runway edge lighting, approach lighting, threshold/end lighting, taxiway lighting, visual slide slope indication, distance-to-go (DTG) marker lighting, and obstruction lighting. Also included are a regulator, control panel, and numerous transformers and lengths of cable. The EALS can be powered from any two wire single phase 15-kVA 208-volt supply. This supply powers a single regulator that powers a series circuit that includes all the EALS lighting equipment except the obstruction lights. All the lighting equipment on this circuit, except the approach strobes, turn on and off in unison. The

regulator has three intensity levels that can be selected at the control panel. Typical layouts of the various components of the EALS are shown in figures 5.3 through 5.6. Normally a six-person crew is assembled to layout and install the system. Details relative to the set up and operation of the EALS can be found in volume 3 of this pamphlet series and TO 35F5-2-17-1.

5.7.2.1. EALS Major Components. The major components of the EALS are described in the following paragraphs. The quantities of components listed correspond to the full EALS system.

5.7.2.1.1. Edge/Approach Lights (116 each). Edge lights (figure 5.7) are positioned in parallel on each side of the runway, up to 10 feet from the runway edge and 200 feet apart. They are identical to, and interchangeable with, approach lights. Also all components of the edge light, except the lens and lamp, are identical to, and interchangeable with, the threshold/end light and taxiway light. The edge and approach lights are omnidirectional and use a clear glass lens and system's series circuit by 45-watt isolation transformers (figure 5.7). The transformers also prevent failure of the entire lighting circuit if a lamp fails.

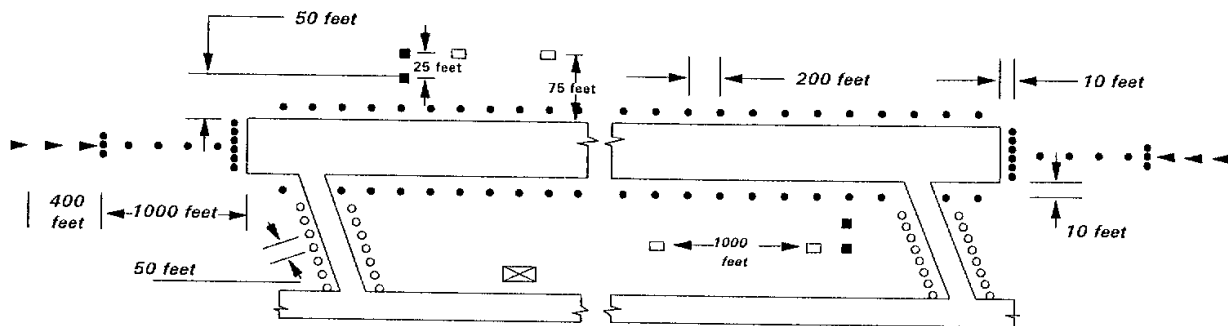
5.7.2.1.2. Threshold/End Lights (33 each). The threshold/end lights (figure 5.7) mark the threshold of the runway at the approach end and the end of the runway at the opposite end. They are positioned parallel to the runway threshold on each end of the runway for the entire length of the threshold. These lights are located up to 10 feet from the runway threshold and are spaced 10 feet apart (see figure 5.5). Threshold/end lights are bidirectional and use a split red and green lens and a 120-watt quartz-halogen lamp. The green half of the lens is positioned to face the approach side of the runway; the red faces the threshold side. All threshold/end lights are connected to the airfield lighting circuit through a 100-watt isolation transformer (figure 5.7).

5.7.2.1.3. Taxiway Lights (40 each). The taxiway lights (figure 5.7) are located on the sections of the taxiways closest to the runway. Taxiway reflectors (252 each) are placed on sections of the taxiways not covered by the taxiway lights. Taxiway lights are located up to 10 feet from the edge of the taxiway and normally spaced 50 feet apart (see figure 5.6). They are omnidirectional and use a blue glass lens and a 30-watt quartz-halogen lamp. Like edge and approach lights, taxiway lights are connected to 45-watt transformers.

5.7.2.1.4. Distance-To-Go Marker Lights (10 each). The DTG marker lights are used to illuminate the DTG marker signs on each side of the runway normally 75 feet off the runway edge and 1000 feet apart. The distance signs themselves are not part of the EALS; therefore, you will either have to use existing markers (if available) or locally manufacture new ones. The DTG marker lights resemble small spotlights and use 45-watt PAR 38 lamps. They also are connected to 45-watt isolation transformers for circuit and fixture protection.

5.7.2.1.5. Isolation Transformers (figure 5.7). As mentioned in the preceding paragraphs, EALS isolation transformers come in two sizes -- 45 watt and 100 watt. There are 163 of the lower wattage and 33 of the higher wattage included in the EALS package.

Figure 5.3. EALS General Layout.



NOT TO SCALE

LEGEND:

- EDGE, APPROACH, THRESHOLD / END LIGHT
- TAXIWAY LIGHT
- APPROACH STROBE
- PAPI
- DISTANCE-TO-GO MARKER LIGHT
- ⊗ GENERATOR, REGULATOR, CONTROL

Figure 5.5. EALS Threshold/End Light and Approach Lighting Layout.

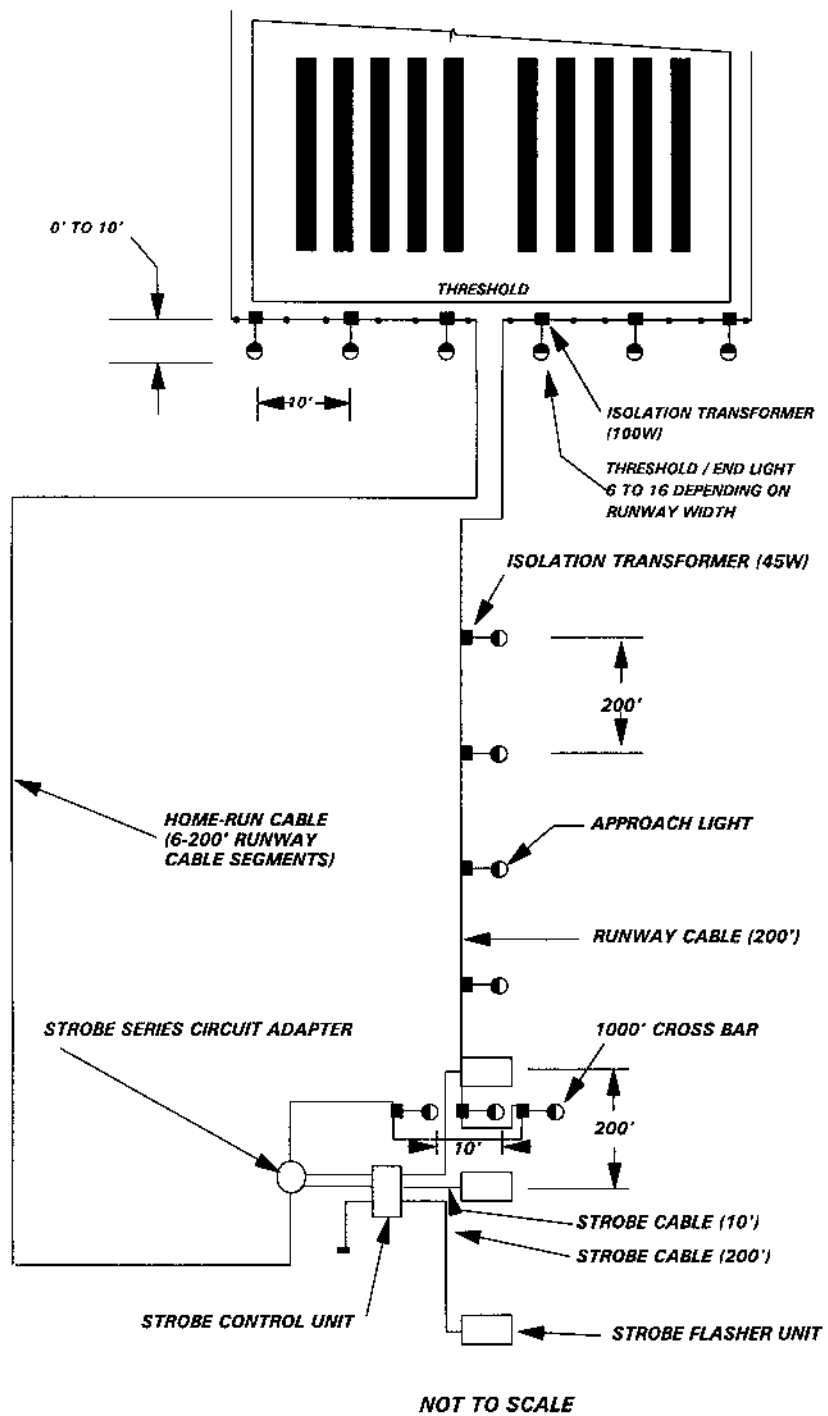


Figure 5.6. EALS Taxiway Lighting Layout.

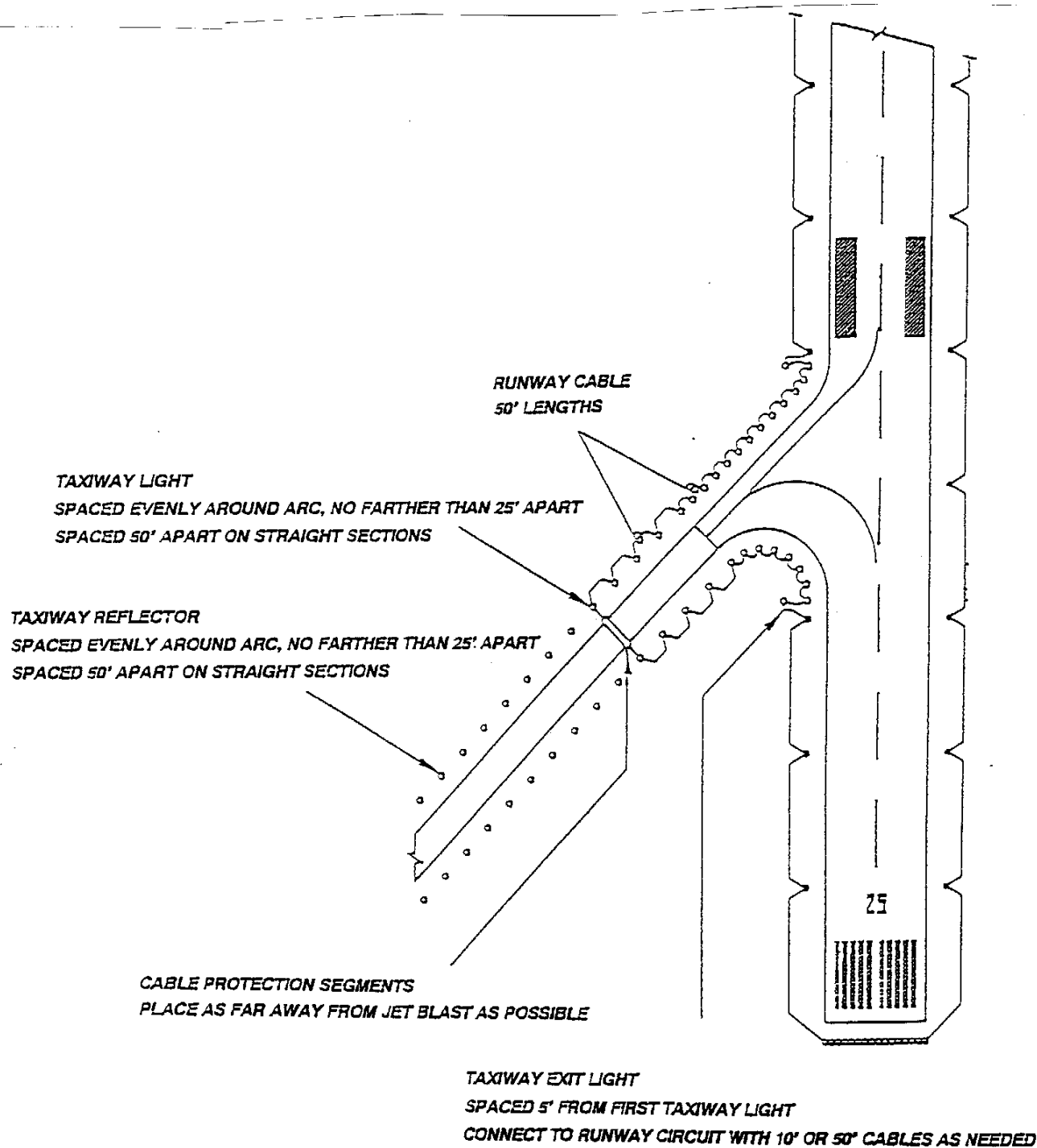
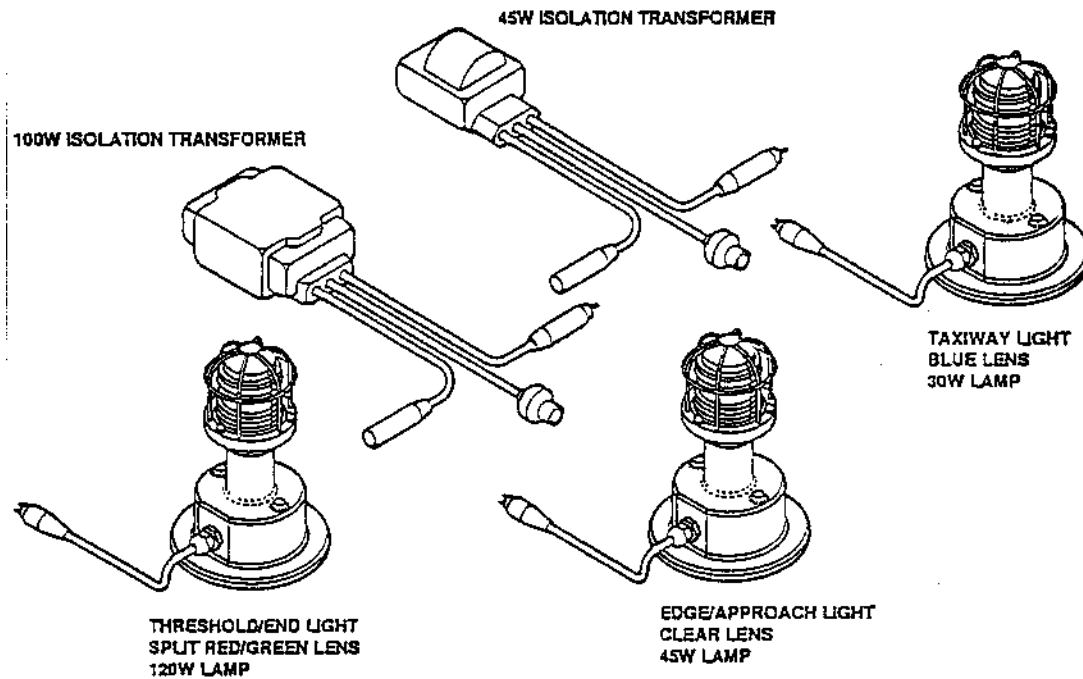


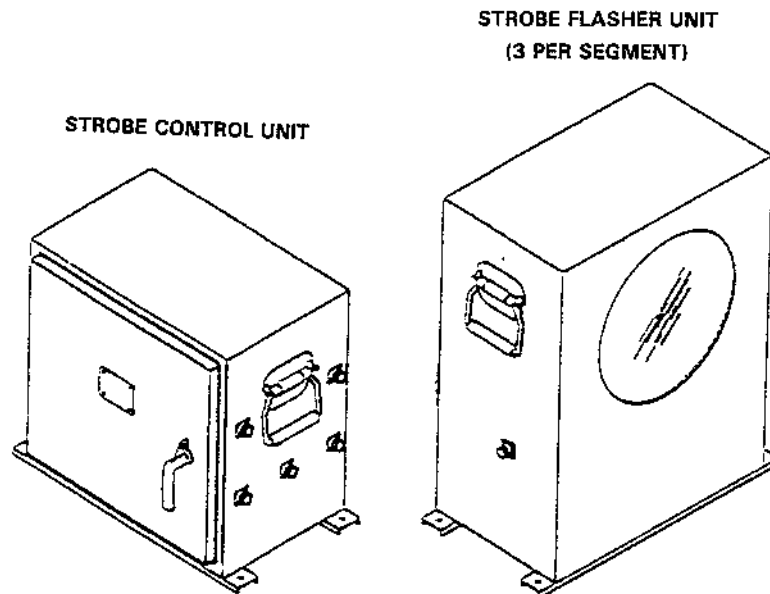
Figure 5.7. EALS Light Fixtures and Transformers.



5.7.2.1.6. Approach Strobes (2 segments). An approach strobe segment (figure 5.8) has three strobe flasher units and one strobe control unit. The strobe flasher units flash in sequence starting at the strobe outermost from the runway threshold. An approach segment is installed at each end of the runway (see figure 5.5). The strobe control unit controls the flashing sequence of the strobe flasher units and is connected to the airfield lighting circuit through a series circuit adapter.

5.7.2.1.7. Precision Approach Path Indicator (PAPI) (5 each). The PAPI units provide visual glide slope indication to incoming pilots. The units are installed near the touchdown points of the runway (figure 5.9). The first PAPI light is placed approximately 50 feet from the edge of the runway. Then approximately 25 feet from the first unit, the second light is positioned. A series circuit adapter connects both lights into the runway circuit. Consult the EALS T.O. for detailed installation procedures.

5.7.2.1.8. Obstruction Lights (10 each). Obstruction lights in the EALS are battery powered and yield a red flashing signal. They are manually controlled.

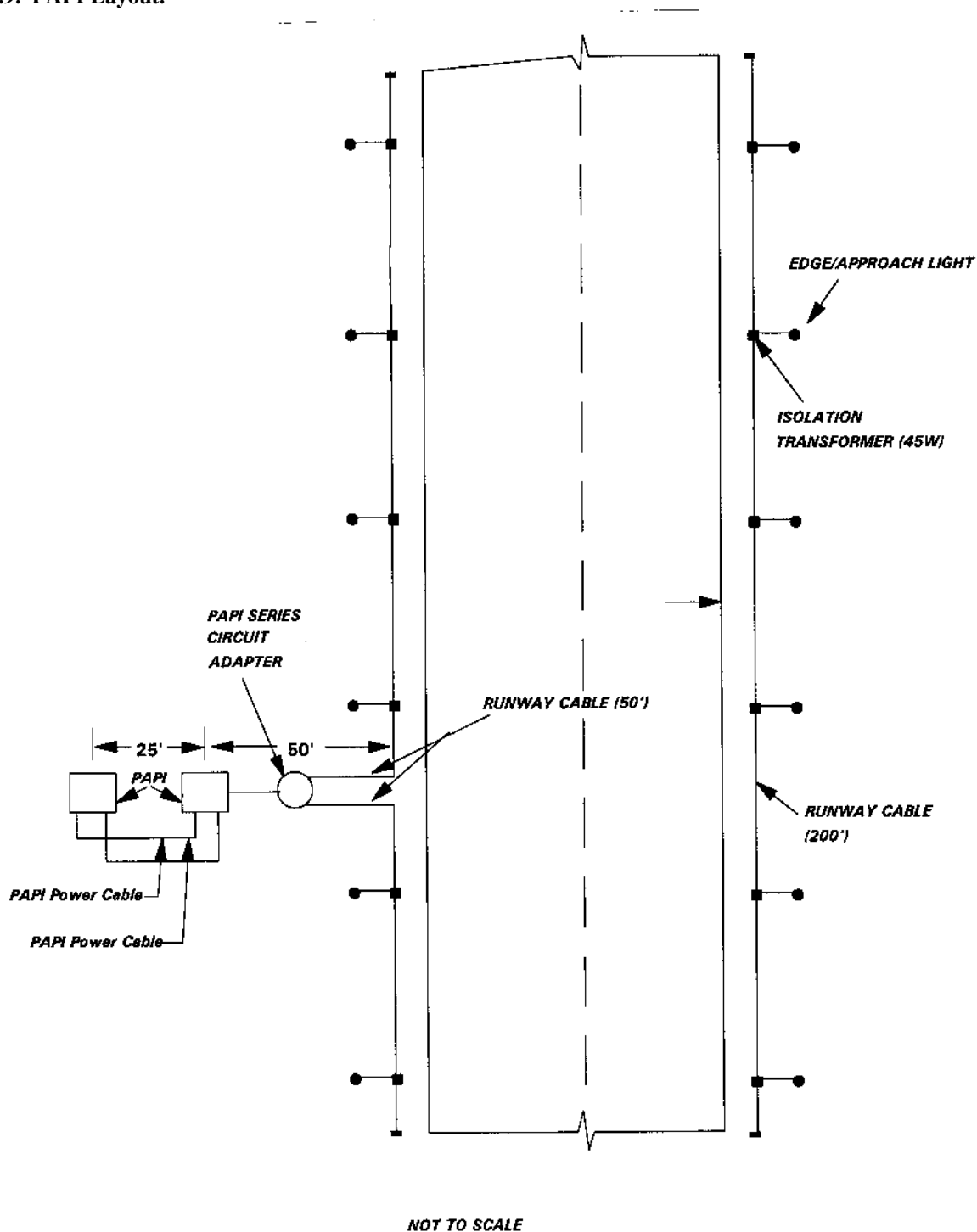
Figure 5.8. Strobe Components.

5.7.2.1.9. Regulator (1 each). The EALS 20-kW regulator provides a constant current power source for the runway lighting circuit. The regulator has three intensity levels (4.8 amps, 5.5 amps, and 6.6 amps) that can be selected at the control panel. Changing the intensity setting of the regulator changes the intensity of the edge lights, approach lights, threshold/end lights, taxiway lights, and distance-to-go marker lights.

5.7.2.1.10. Control Panel (1 each). The control panel permits the operator to control the operation of the EALS and allow a system blackout (deenergizing runway and strobe lights). Controls are provided for operation of the runway lights, selection of intensity settings, and selection of strobe lights.

5.7.2.1.11. Cable. Over 33,000 feet of cable in varying lengths and gauges are included for connecting lights, transformers, control boxes, the regulator and control panel, etc.

Figure 5.9. PAPI Layout.



5.8. Aircraft Arresting Systems. While there are several types of aircraft arresting systems in use in the Air Force inventory, you will probably only encounter two types for use in a bare base situation -- the BAK-12 system and the mobile aircraft arresting system (MAAS). The BAK-12 system is normally installed by RED HORSE personnel whereas the MAAS can be installed by either RED HORSE or Prime BEEF forces.

5.8.1. BAK-12 System. The BAK-12 aircraft arresting system (figure 5.10) consists of two rotary friction energy absorbers joined across the runway by a steel cable. The friction brake discs on each absorber are driven by a reel which houses the roll of nylon purchase tape that pays out during an arrestment. To facilitate engagement by tail hook equipped aircraft, the hook cable is maintained several inches above the active runway or overrun by rubber discs. The ability of the BAK-12 to arrest in either direction permits hook equipped aircraft to make precautionary approach arrestments as well as the more frequently required departure-end arrestments. One BAK-12 system is included in the Initial Flightline Support set of the Harvest Falcon package.

5.8.1.1. BAK-12 Installation. The BAK-12 can be readily installed anywhere in the world. The established practice at fixed bases is to bolt each absorber to a concrete pad for surface installation or in a concrete pit for below grade installation. It can also be installed with earth anchors in an expeditionary installation (figure 5.11) requiring approximately 100 hours of labor within an elapsed time of 10 clock hours. The topography of the area upon which the barrier system is to be placed as well as the runway or overrun surface in the areas of the barrier must be carefully examined to determine installation requirements or alterations. The area the system will be placed upon (if off the runway) should be reasonably flat. Grading of the area may be required during construction to meet this requirement. The area should be well drained. No surface undulations greater than 0.125 inches are allowed in any 10 feet of longitudinal surface area at the center 50 percent of the runway. The barrier must be positioned to allow for a minimum aircraft run-out of at least 950 feet after engagement and ideally 1,000-1,500 feet of crater free pavement ahead of the barrier cable.

5.8.1.2. BAK-12 Operation. The BAK-12 is a completely self-contained system. It operates from a gasoline engine which is an integral component of the system and does not require an external source of power, water, or compressed air. Water in a 55-gallon drum is used, however, for cooling brake surfaces during rapid rewind procedures. When used as an emergency system, the BAK-12 is normally unattended and operates automatically when an aircraft engages the cable. A minimum three- to four-member barrier crew will be required to retract and reset the system. Two of the crew members operate the retract engines and the remaining one or two personnel act as signalmen. The crew size used is normally dependent on the width of the runway that the barrier is serving. Installation and operating instructions beyond the detail of this pamphlet are contained in TO 35E8-2-5-1.

Figure 5.10. BAK-12 Aircraft Arresting System.

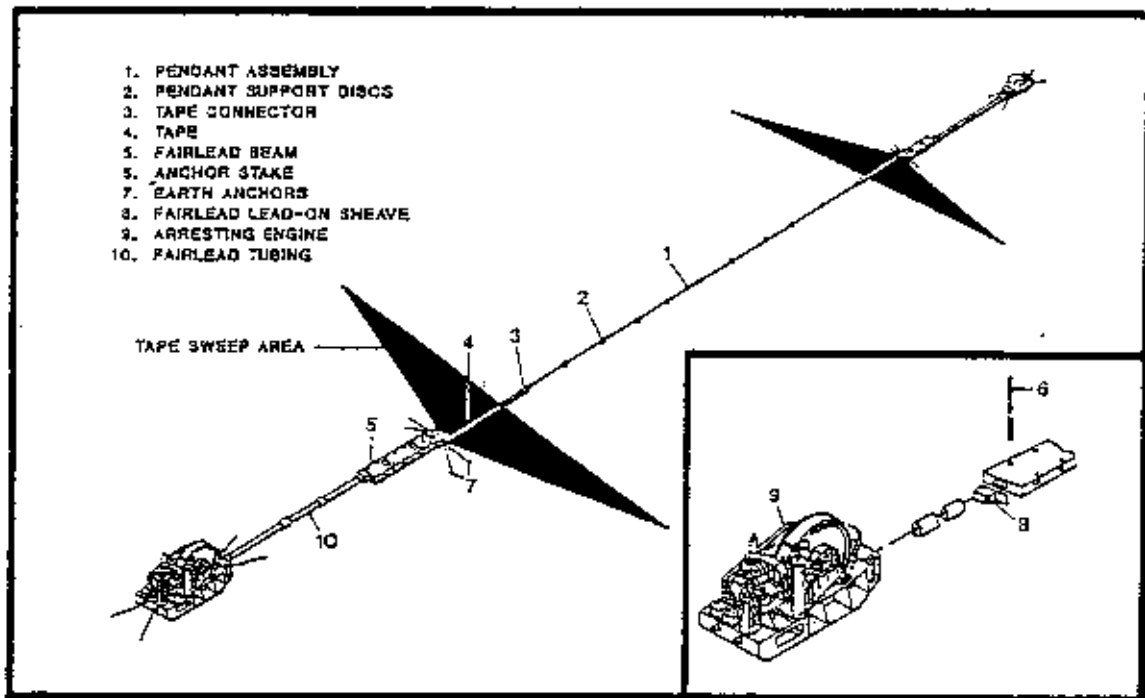
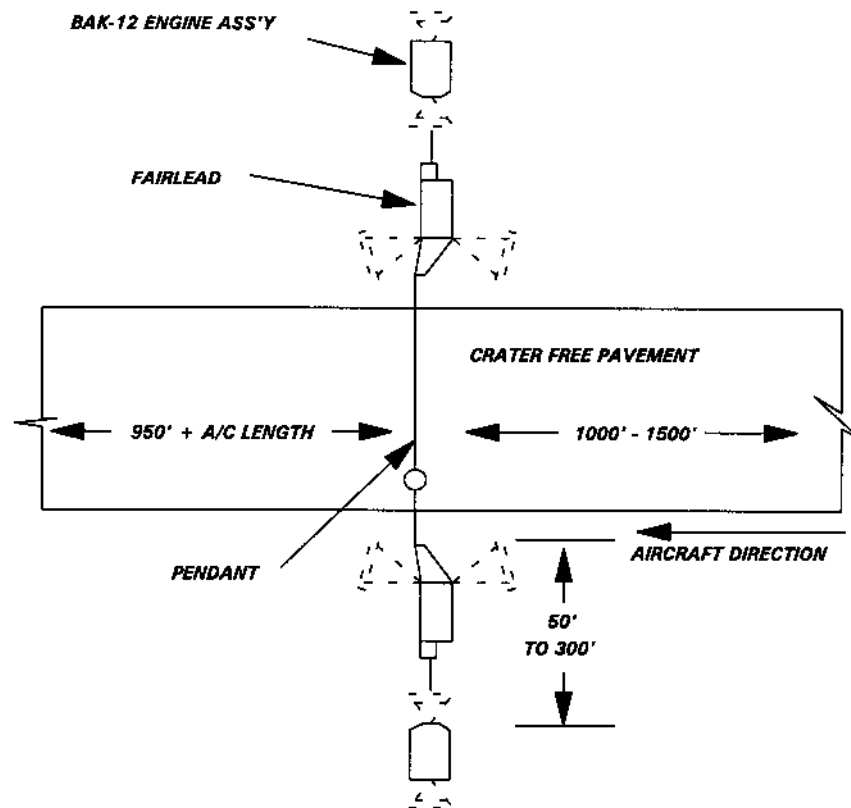


Figure 5.11. BAK-12 Expeditionary Installation.



5.8.2. Mobile Aircraft Arresting System (MAAS). The primary purpose of the MAAS (figure 5.12) is to provide for rapid deployment of aircraft recovery capability, enabling high cycle arrestment of hook-equipped tactical aircraft on airfields not having a compatible permanently installed arresting system or those that have been expediently repaired after base attack. The MAAS is easily transportable by air or land and can be set up on various types of surfaces. The MAAS is equipped with a BAK-12 energy absorber and is capable of bidirectional arresting. One MAAS is included in the Initial Flightline Support set of the Harvest Falcon package.

5.8.2.1. MAAS Features. For over-the-road travel, the MAAS is equipped with a full complement of hydraulic brakes and running lights. The MAAS has a tow bar which, terrain permitting, allows it to be towed at speeds up to 55 mph. A pintle hook located on the rear of each trailer provides a tandem tow capability. For air travel, the complete system is transportable in one C-130 aircraft (figure 5.13). The MAAS is also equipped with an on-board winch which allows loading and off-loading onto transport aircraft without a tow vehicle. This feature can be useful when degraded terrain conditions are encountered to extract the system from snow, ice, sand, or soft earth. The complete system consists of two trailer-mounted arresting units, one positioned on either side of the operational runway, connected by an arresting cable assembly. Two cable lengths are available--90 feet and 153 feet. The MAAS has demonstrated a rapid cycle arrestment capability, providing for up to 20 arrestments per hour.

5.8.2.2. MAAS Installation. The MAAS can be installed on surfaces ranging from soil to asphalt to concrete. The following paragraphs provide an overview of MAAS installation on various surfaces. Detailed installation instructions are contained in TO35E8-2-10-1 and Volume 3 of this pamphlet series. The size of the MAAS installation crew and the time required to install the system will be dictated by the contingency situation. On the average, an experienced ten-person crew should be able to install the MAAS in approximately 20 minutes.

5.8.2.2.1. Concrete Surface. Depending on runway location and mission requirements, the MAAS may be installed on concrete using two available methods.

- Off Runway. To install the MAAS off the edge of the runway surface, a concrete cruciform foundation with cast-in anchor nuts is prepared. Three lightweight anchor plates are then aligned over the nuts and tightened to the foundation using anchor bolts. Once the anchor plates are secured, the MAAS is attached to the anchor plates with a turnbuckle assembly. The adjustable turnbuckle assembly is an advantage because it does not require precise alignment between the arresting system and the anchor plate, resulting in a shorter installation time.
- On Runway. The MAAS can also be installed directly on the concrete runway surface if there is no available cruciform foundation. Under this method the anchor plates are used as templates to bore holes in the concrete runway surface using a hydraulic drill supplied with the arresting system. Taper bolts with expansion nuts are then inserted and tightened. The turnbuckle assembly is then tightened, securing the system to the runway. See figure 5.14 for typical installation drawing.

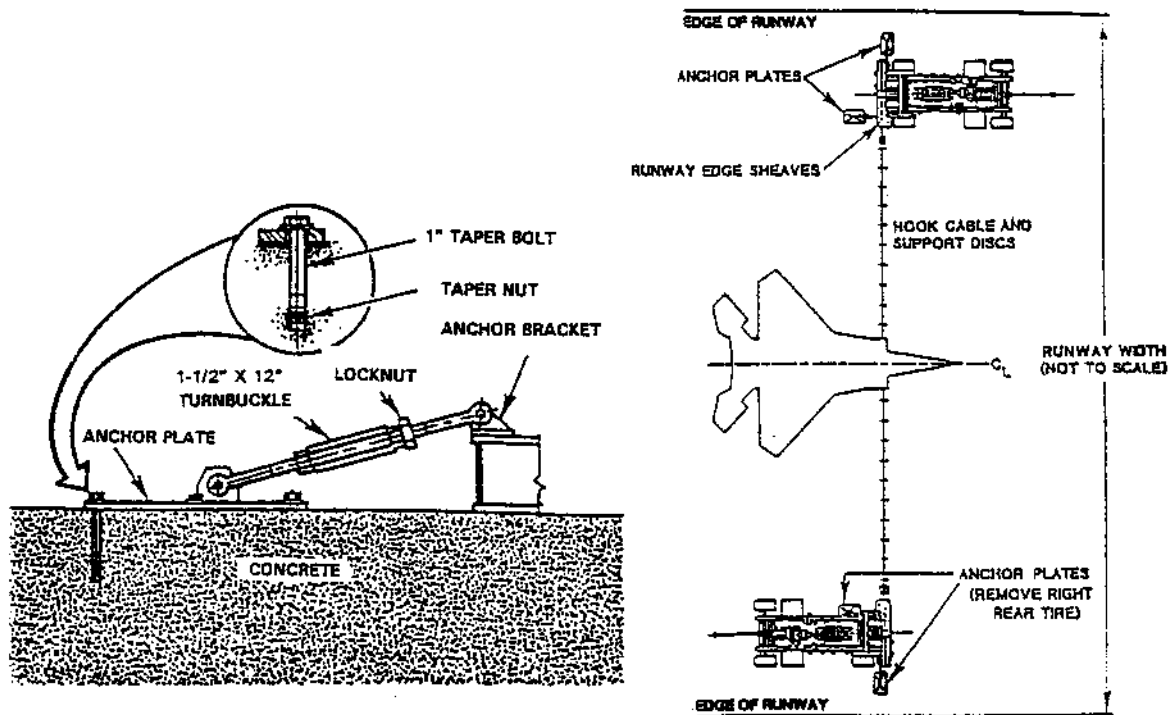
Figure 5.12. Mobile Aircraft Arresting System.



Figure 5.13. System Loading on C-130.



Figure 5.14. MAAS Concrete Installation.



5.8.2.2.2. Soil Surface. When the MAAS is installed on a soil surface it is held in place using an all-stake anchoring arrangement designated the K-M anchor system. The system consists of standard USAF high-strength aluminum stakes linked together by an assembly of aluminum stake ties, spacers and guides (figure 5.15). The stakes are driven into the soil using a hydraulic jackhammer which is provided with the system (figure 5.16). Turnbuckles are used to connect the anchor assembly to the arresting system body. In addition to the K-M anchor system, stakes are driven through ten stake pockets on the arresting system body to complete the installation. An advantage of the K-M anchor system is the ability to adjust the position of the assembly if a rock or other obstacle is encountered during stake driving operations. Removal of the MAAS from a soil installation can be quickly accomplished using the hydraulic stake puller tool provided with the system. All anchoring hardware can be recovered and used for future installations. Experience has shown, however, that over time additional aluminum stakes will be needed as replacement items.

Figure 5.15. Soil Installation Using K-M System.

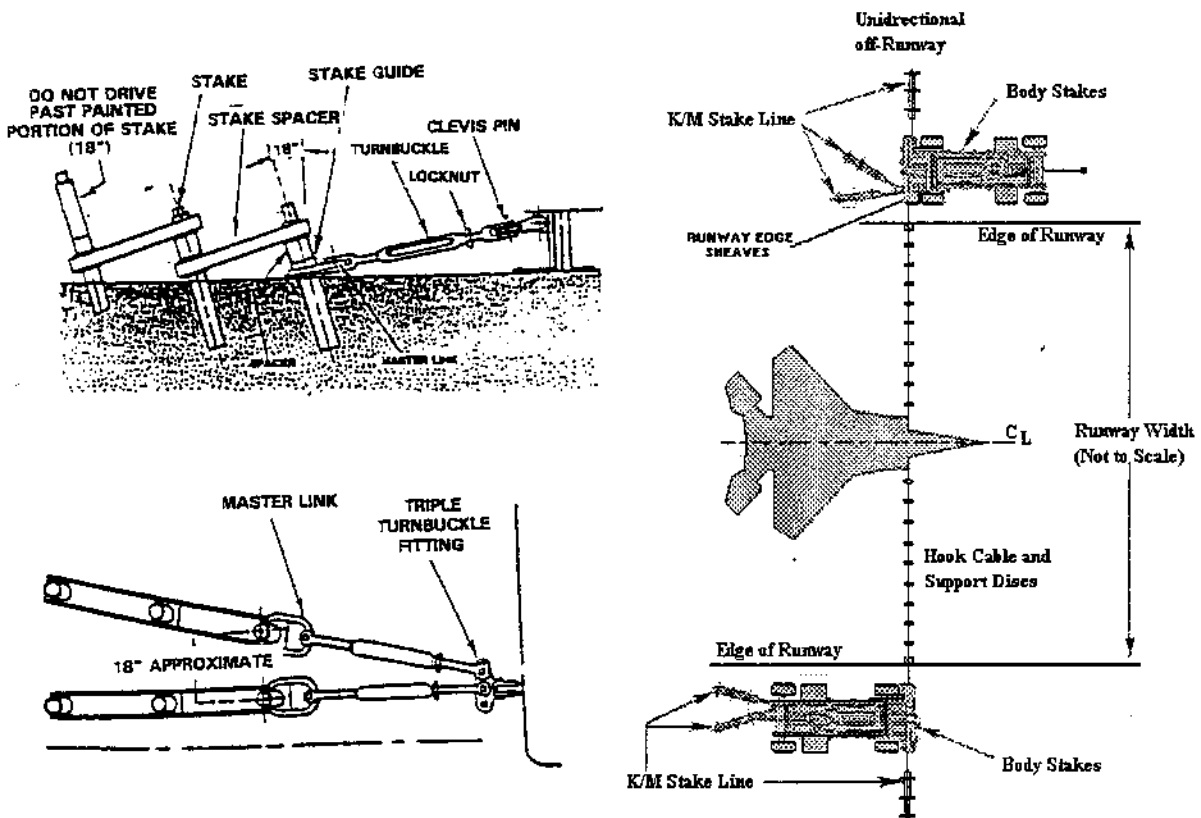


Figure 5.16. MAAS Hydraulic Jackhammer.



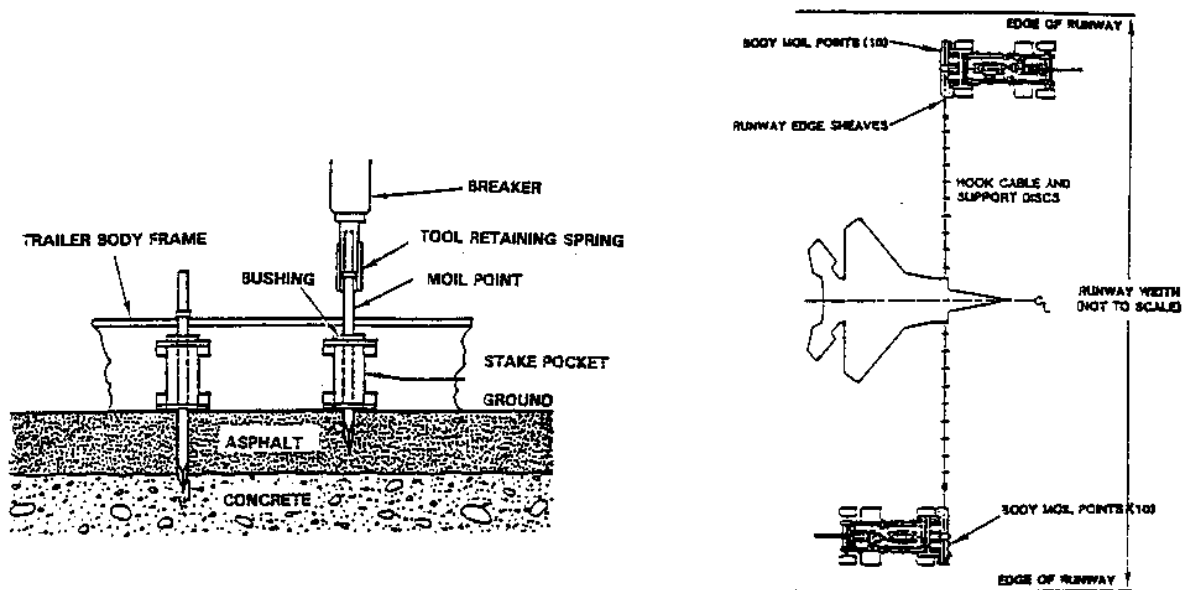
5.8.2.2.3. Asphalt Surface. The method used to install the MAAS on an asphalt surface will depend on the thickness of the asphalt and the composition of the subgrade. For asphalt surfaces up to six inches thick over a soil subgrade, the K-M anchor

system is used. The asphalt is chipped away using the hydraulic jackhammer and a chisel attachment. The stakes are then driven through the stake spacers into the soil subgrade. The procedure is the same as the soil installation, except the body stakes are not required in asphalt.

- If the asphalt is greater than 6 inches thick, or if the subgrade is concrete, the moil point anchor system should be used (figure 5.17). The moil point system uses the 10 body stake pockets with bushings. Under this system, 24-inch standard moil points are inserted into the pockets and driven through the asphalt into the subgrade using the hydraulic jackhammer.

Both stakes and moil points are removed using the stake puller tool included with the arresting system. As in the soil installation, all installation hardware can be recovered for future use.

Figure 5.17. Moil Point Installation.



5.9. Navigational Aids. If NAVAIDS are not available at the bare base, they must be installed. The basic criteria for locating navigation aids are listed below. Final siting and installation is the responsibility of communications personnel.

5.9.1. Tactical Air Navigation (TACAN). Should be located a minimum of 1,000 feet from the runway centerline. Should not be located near the low frequency beacon.

5.9.2. Beacon. Should be located a minimum of 1,000 feet from the runway centerline. Should not be located near TACAN.

5.9.3. Radio (TROPO and TSC 70 HFISR). The physical location is flexible. A clear area for the scope antenna is required.

5.9.4. Radar Approach Control (RAPCON). Should be located a minimum of 500 feet from the runway centerline in a clear area where both approaches can be observed. The search antenna should be clear in all directions.

5.9.5. Tower. Should be located a minimum of 500 feet from the runway centerline in a location which provides visual surveillance of all taxiways and runways.

5.9.6. Wind Sock. Should be located in an area visual to taxiing aircraft.

5.10. Aircraft Revetments. Enemy air, artillery, rocket and ground attacks against a bare base are likely to center on our aircraft, by far the most lucrative and, when parked in the open, the most vulnerable targets available. Consequently, when the bare base site is located in a high threat area, you should plan to provide revetments for the protection of parked aircraft.

5.10.1. Revetment Protection Features. Revetments protect parked aircraft from three dangers. First, they block shrapnel and deflect blast from near misses by enemy aerial munitions and indirect fire weapons (artillery, rockets, and mortars). Second, revetments screen aircraft direct fire weapons on the ground. Third, revetments will prevent chain reaction explosions from one aircraft to the next. Dispersed revetment cells on separate parking pads (figure 5.18) provide greater protection from air attack because they are point targets rather than line targets. Where dispersed revetment parking is not possible, revetments can be erected on the mass parking apron in one or more of several cluster arrangements (figure 5.19).

The "U" shape cluster arrangement could be erected along a taxiway if AM-2 matting is available for parking pads. The multiple group, "H" shape cluster arrangement provides each aircraft protection on three sides and has no line-of-sight to other parked aircraft. Line-of-sight parking posed a problem in Vietnam where aircraft were occasionally destroyed despite revetments because forward firing weapons on one aircraft pointed directly at other parked aircraft. The drive-through cluster layout shown in figure 5.19 allows quick entry and exit, but lacks the protection of a third wall. With proper positioning of the drive-through clusters, aircraft in adjacent rows still have line-of-sight protection.

Figure 5.18. Dispersed Revetment Cells.

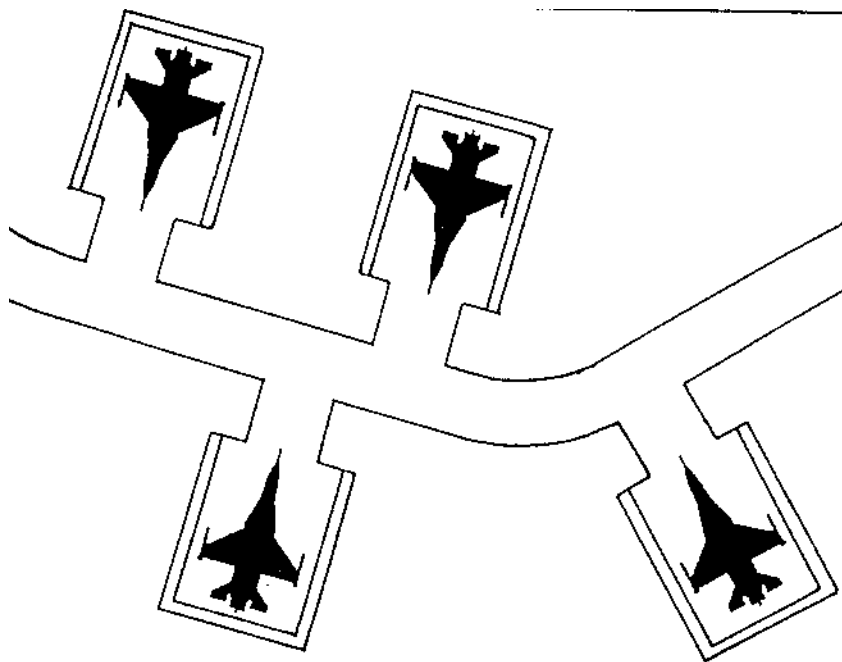
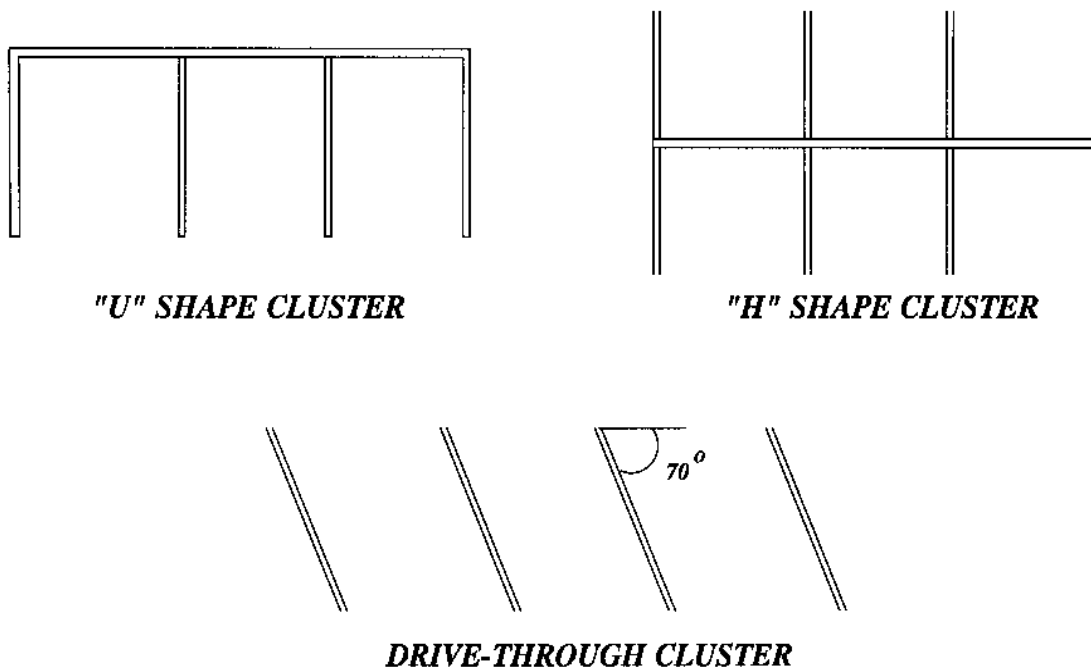


Figure 5.19. Cluster Arrangements for Aircraft Revetments.

5.10.1.1. Standard Revetments. Several types are available, however, the one most likely to be available is the B-1 revetment kit. The Initial Flightline Support set of the Harvest Falcon asset package contains 42 revetment kits. Shipped in 21 sections, each 12 feet long, the B-1 kit provides 252 lineal feet of steel bins that are 16 feet high and nearly 7 feet wide. For bare base planning, one revetment kit is required for one tactical aircraft. Two revetment kits are required for each cargo or strategic aircraft; however, since two B-1 kits do not provide sufficient material for dispersed revetment cell construction, one of the cluster arrangements shown in figure 5.19 must be used for those large aircraft. A typical revetment layout for tactical aircraft is shown in figure 5.20. Revetments are assembled from 16 and 18 gauge corrugated steel panels pinned together with 1/4-inch diameter rods. Assembled in place, the bins must be filled (depending upon availability) with soil, sand, or gravel (figure 5.21). The bill of materials, packaging information, and equipment required for the erection of the B-1 revetment are contained in attachment 3. Detailed assembly instructions are provided in chapter 4 of volume 2 of this pamphlet series.

5.10.1.2. Non-Standard Aircraft Revetments. Non-standard revetments can be constructed from shipping containers, timber cribs, retaining walls of wood or matting, berms of piled earth or soil cement, and sandbags. Non-standard revetments are covered in chapter 3 of volume 2 of this series.

5.10.1.3. Quick Turn Revetments. A quick turn (or combat turn) facility is a group of parallel drive-through revetments where aircraft are refueled and rearmed rapidly. As is common practice in overseas theaters, plan on locating a quick turn facility a safe distance from where the mass of aircraft will be parked at the bare base. Aircraft are normally spotted in alternate cells with ground support equipment and vehicles in between. The danger of loading munitions on unprotected aircraft was tragically illustrated at Bien Hoa Air Base in Vietnam where an accident triggered numerous chain reaction explosions that destroyed 14 aircraft, damaged 31, and caused 105 casualties.

5.10.1.4. Critical Airfield Facility Revetments. You should coordinate with other base agencies to determine which airfield facilities should be protected by revetments. Figure 5.22 shows a typical layout for B-1 revetment kit sections used to protect mobile TACAN and GCA facilities. Facilities commonly considered for reveting include utility plants and substations, squadron operations, command posts, and communications to name a few. When standard revetment materials are in short supply, you may have to depend on non-standard expedient revetments to protect equipment essential to sortie generation.

Figure 5.20. Typical Layout of B-1 Revetment Kit.

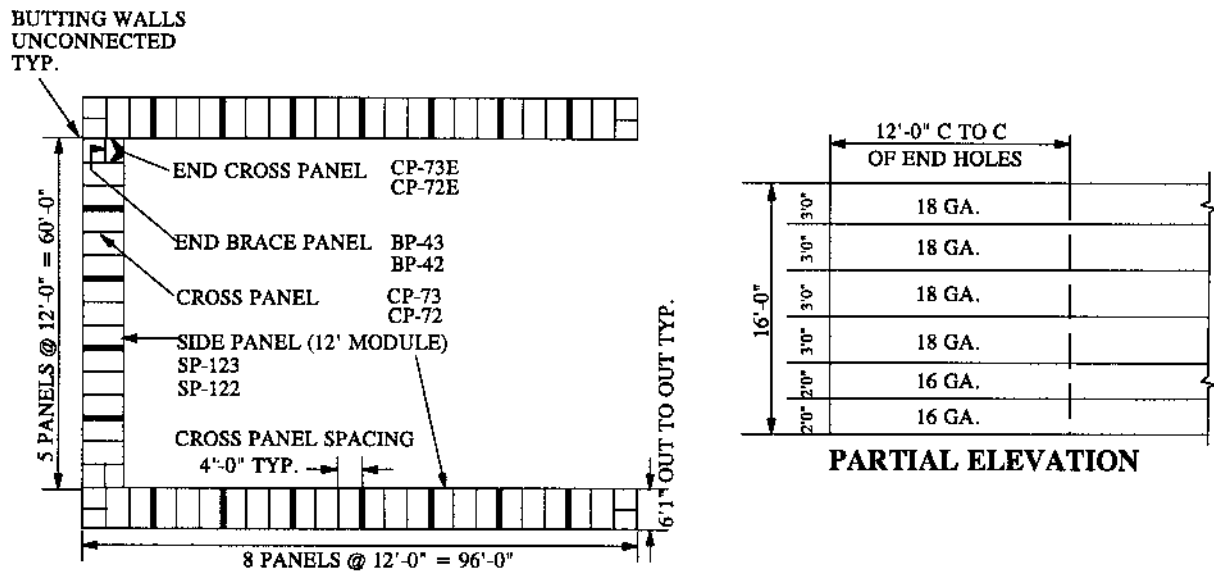
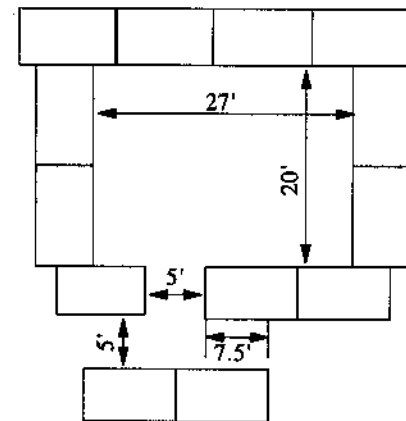
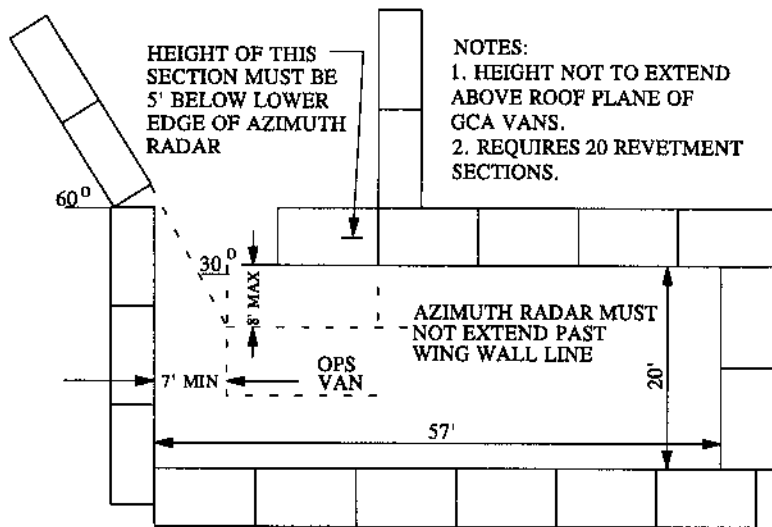


Figure 5.21. Bin Revetment.

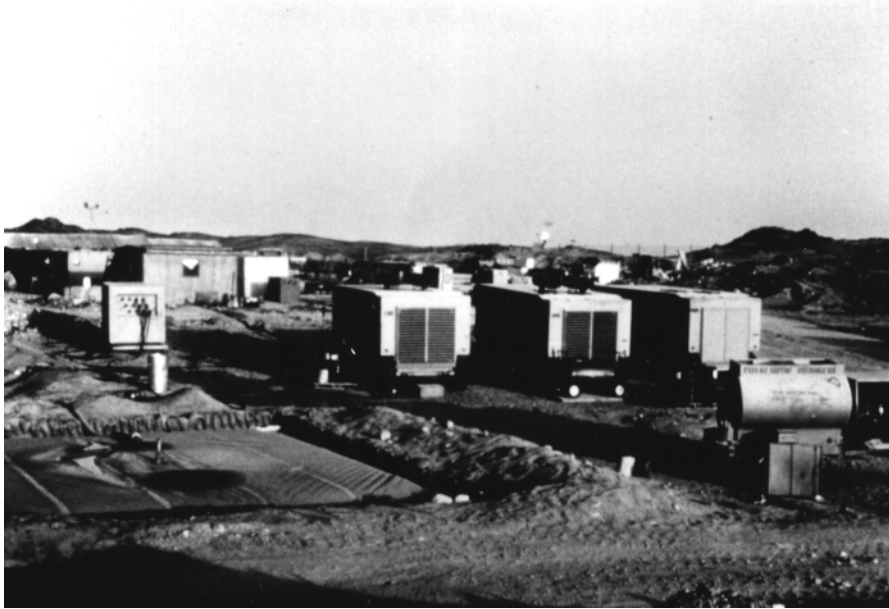


Figure 5.22. B-1 Revetment Layout for GCA and TACAN.



Chapter 6

ELECTRICAL UTILITY SYSTEMS



6.1. Introduction. Bare base electrical packages consist of both high and low voltage systems. The high voltage system is normally associated with Harvest Falcon type assets; low voltage relates primarily to Harvest Eagle. High voltage generators are 3-phase, 2400/4160 volts AC, wye connected; power is transmitted in delta, using the 4,160 volts to energize the primary side of the power distribution transformers, where it is stepped down to 3-phase, 120/208 volts. The Harvest Eagle electrical system depends primarily on 30- and 60-kW generators; it also can be powered by Harvest Falcon systems or by any number of DOD low voltage generators. Also supporting the Harvest Eagle system are separate high voltage electrical utility packages meant to be used when air conditioning units are deployed along with Harvest Eagle assets.

6.2. Overview. The discussion of Harvest Eagle and Harvest Falcon electrical systems - constituting the major part of this chapter - is preceded by general guidance for power plant dispersal and environmental considerations. This chapter also considers other aspects of bare base electrical power generation and distribution such as primary cable reels and pallets, secondary distribution centers (SDCs), primary distribution centers (PDCs), remote area lighting (RAL), secondary cable assemblies, power distribution junction boxes, and mission essential power (MEP) cable assemblies.

6.3. General Guidance.

6.3.1. Dispersed Layout. For maximum efficiency of both personnel and equipment, the optimum mode of operation is to generate all the primary power at a centrally located power plant. However, a dispersed layout could prevent the total loss of your generating capability in an area with a high attack threat. You should plan on providing up to four separate power plants, each separated by distances of 1,500 to 3,000 feet. These plants should be electrically tied together in a loop feeder system. This configuration would allow a back feed capability to most of the base in the event of enemy bomb damage; it would also allow operators to switch generators off during periods of light load and maintenance shutdown periods.

6.3.2. Electrical Generation. High ambient temperatures adversely affect the performance of diesel electric generator (E-G) sets used for bare base systems. To help reduce these effects, the sets should be located so that the prevailing winds will carry the heat away from adjacent generator sets or occupied areas. It is recommended that E-G sets be shaded from direct sunlight to prevent engine over temperature shutdown. Additionally, E-G sets should be protected, to the highest practical extent, from blowing dust and sand entering cooling air intakes. The volume of air intake cannot be restricted or heat buildup will occur causing loss of power. One method is to position very porous (cheese cloth) fabrics around (but held several feet away from) air intake louvers or radiators and precool and cleanse the air by water misting. The cheese cloth and air intake filters must be cleaned frequently. This cannot be overemphasized. Protect air intakes and exhaust ports on non-operating sets and

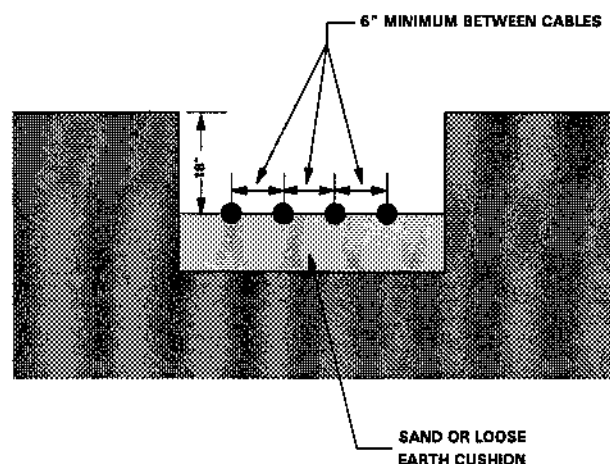
fuel and oil tanks during oil and fuel servicing operations. An accelerated maintenance schedule must be anticipated in high temperature and arid environments.

6.3.3. Electrical Distribution. The urgency of most bare base deployments dictates that electrical utilities be provided on short notice. In such cases, initial electrical power is normally provided to mission essential facilities using low voltage mobile generators (mission essential power (MEP) generators). Typical facilities served would include command posts, squadron operations facilities, control tower, communications, etc. Once these generators are in-place, on-the-ground layout of electrical distribution cables and placement of SDCs, PDCs, panel boxes, larger generators, etc. commences. As these items are connected and facilities brought on-line on the base electrical distribution grid, the MEP generators are normally relegated to backup power status. This on-the-ground distribution concept is used exclusively during the early phases of a deployment and also on deployments of short duration. But for extended bare base operations, you must plan on a simplified underground primary distribution system to protect the cables from extreme climatic elements. Overhead primary distribution systems are not recommended since they require poles. Wood is often scarce in some of the potential deployment areas or subject to premature failure. Other materials such as concrete, aluminum, or steel could be used but are impractical. A simplified underground distribution system has no conduits, manholes, or vaults. Instead, the primary cables are buried directly in the ground about 18 inches (but not less than 12 inches) deep (figure 6.1) and transformers and junction boxes are housed above ground in metal enclosures. It should be noted that this simplified underground distribution system is not readily adaptable to distribution system growth and extension.

6.3.4. Power Conditioning. If power conditioning is required, the user must provide this capability with the specific equipment that requires conditioned power.

6.3.5. Host Nation Power. A major assumption often included in exercise scenarios - and in this chapter - is that host nation electric power will not be available for, or is not compatible with, bare base power demands. However, many countries do have limited electric power distribution networks that would be useful when troops start to build the base. If host nation power is available, its use should be planned to supplement existing bare base generation capability; this would vastly reduce fuel consumption. The base must, however, maintain its own internal generation and distribution system in case host nation power is cut off. Most power grids outside the US and Canada use power generated at 50 hertz (Hz), single or 3-phase, which can be used in many cases to power electric lights and heating elements. However, only equipment specifically designed as compatible with 50 Hz power should be so connected. Most Air Force equipment and utilities are designed for 60 Hz and operating at 50 Hz will cause permanent damage. Table 6.1 lists electric power characteristics available in various countries around the world. Attachment 4 lists the diversity of electric power and its characteristics in various countries of SWA. It should be noted that the quality of power in this region of the world is generally poor, frequency stability and voltage regulation are substandard, and high-level voltage transients are possible.

Figure 6.1. Electric Cable Burial.



6.4. Harvest Eagle Electrical System.

6.4.1. Power Generation. The Harvest Eagle electrical system provides lighting and duplex convenience outlets to billeting, organizational shop, administrative, office, and command-level tents. The system can be powered either from Harvest Falcon secondary distribution centers (SDCs) and associated power grid or it can be powered by any number of DOD low voltage generators; however, the system depends primarily on 30-kW and 60-kW generators currently in Harvest Eagle inventories. The Harvest Eagle electrical distribution system provides an open loop (one path of power flow to the load), 120/208-volt, 3-phase power for a 550-person deployment. For 1,100-person deployments, two of the Harvest Eagle electrical systems are required.

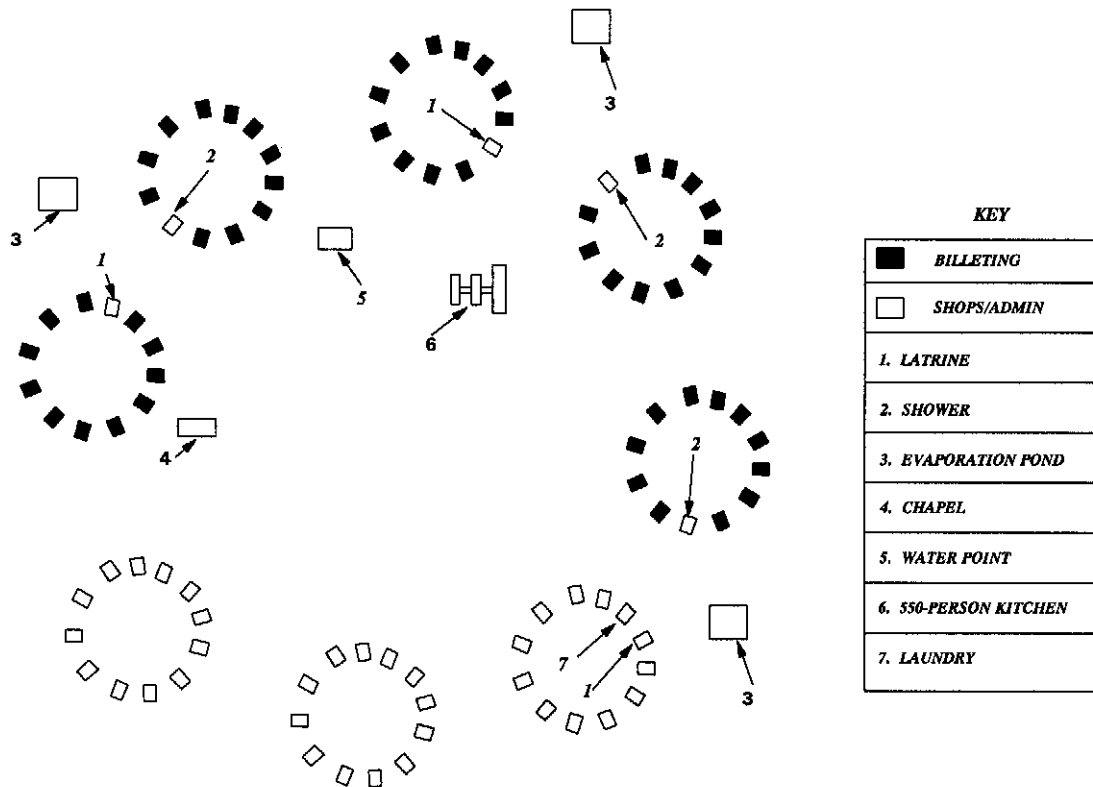
6.4.2. Power Distribution. The urgency of most Harvest Eagle deployments dictates that electrical utility lines and distribution panels be provided on-the-ground in short notice and that the system be installed and retrieved by someone less than a fully qualified electrician. Additionally, the optimum mode of operation would be to have both main and branch feeder cables as short as possible, but the need to disperse in high threat areas requires longer than optimum circuit lengths.

Table 6.1. Air Base Commercial Power Supplies.						
	3-PHASE SYSTEM			1-PHASE SYSTEM		
	Voltage	Wire	Frequency	Voltage	Wire	Frequency
Belgium	220/380	4	50 Hz	220 or 110	2	50 Hz
Canada	550 or 220	4	60 Hz	120	2	60 Hz
Denmark	220/380	4	50 Hz	220	**	50 Hz
France	220/380	4	50 Hz	*	2	50 Hz
Germany	220/380	4	50 Hz	220	**	50 Hz
Greece	220/380	4	50 Hz	220	2	50 Hz
Italy	220/380 or 127/220	4	50 Hz	*	2	50 Hz
Netherlands	220/380	4	50 Hz	220	2	50 Hz
Norway	220	3	50 Hz	220	2	50 Hz
	220/380	4	50 Hz			
Portugal	220/380	4	50 Hz	220	2	50 Hz
United Kingdom	240/416	4	50 Hz	240	**	50 Hz
United States	120/208 or 277/480	4	60 Hz	120/240	3	60 Hz
* 1-phase supply generally possible. ** 2 plus ground NOTES: 1. Voltages on 3-phase systems shown as 220/380; for example, indicate 220 volt line to neutral and 380 volt line to line. 2. Italy - 127/220 will eventually be withdrawn.						

6.4.2.1. The distribution system allows separation of each tent and each module (a group of 12 tents arranged in circular fashion) by a minimum of 60 feet. This dispersed pattern represents a worst case scenario for the planner. The electrical system for each 550-person Harvest Eagle deployment supports eight separate modules, called a module group (figure 6.2).

6.4.2.2. The tents in each module group (there can be as many as 96 tents) receive their power from two 60-kW or four 30-kW generators. Each generator is connected via a 200-amp secondary distribution cable to a secondary distribution panel, the A-panel. Each A-panel, in turn, provides power to four separate 20-kW secondary distribution panels, the B-panels. Each B-panel powers twelve 20-amp branch circuits for the tents. Each tent receives a lightweight distribution box to power six lights and 12 duplex outlets.

Figure 6.2. Module Group Layout - 550-Person Harvest Eagle.



6.4.2.3. The layout of Harvest Eagle tents provides the maximum dispersal of assets under the limitations and constraints of a low voltage system. If the deployment is to a low threat area where maximum dispersal is not required, spacing distances between tents and modules can be reduced accordingly. For dispersal conditions, however, secondary cables are simply plugged together similar to household extension cords to gain the desired lengths. Total cable distances from the generator to the point of use should not exceed 800 feet.

6.4.2.4. For planning purposes, the dispersed distance used in this operational concept is 700 feet (550 feet from A-panel to B-panel and 150 feet from B-panel to each tent). The expected voltage drop at full load for 550 feet of #6 AWG conductor (65 amperes, 95 percent power factor, and 75 degrees Fahrenheit temperature) is about 16 volts. The voltage drop on 150 feet of #12 AWG conductor (16 amperes, 95 percent power factor, and 75 degrees Fahrenheit temperature) is about 4.5 volts. If the generator is producing 120/208-volts, 3-phase power, there will be approximately a 20.5 volt drop at the tent. To remedy this situation, the output voltage can be increased at the generator to approximately 130/225 volts. This will provide a corresponding increase at each tent to 110 volts, which is acceptable.

6.4.3. Electrical Computation. Computation of generator demands and feeder peak loads are based on 2,000 watts or 2 kW per tent (six 75-watt bulbs consume 450 watts leaving 1,550 watts for outlets), or 24 kW per module. That product is then multiplied by a 0.7 diversification factor which reduces the total peak demand per module to 16.8-kW or 67.2-kW per generator. Since MEP generators are capable of 10 percent overloads for several hours at a time, the 60-kW generator will carry these peak loads. Should the load exceed the generator's capability, low priority branch circuits can be shed until a safe operating range is achieved.

6.4.4. Cables. Harvest Falcon secondary cable assemblies come in both 60 and 200-amp sizes. The 60-amp cable assembly is available in two versions: as 4-wire, #6 AWG conductor with ground, or as 5-wire #6 conductor. The 60-amp cable comes in lengths of 25, 50 and 100 feet; the Harvest Eagle system employs only 50- and 100-foot lengths. The 200-amp cable assembly is a 4-wire, #4/0 conductor with ground and is 25 feet long. Two additional cables are used to bring power to the tents; one cable is 50 feet long, the other 100 feet. These cables are 2-wire, #12 AWG copper conductor with ground and have THW-rated insulation for wet and dry locations. Each cable has a 2-pole, 3-wire grounding NEMA male locking plug connector at one end of the cable and a 2-pole, 3-wire grounding NEMA female locking receptacle connector on the other end.

6.4.5. Grounding. Electrical grounding is very important to ensure both a safe and reliable operation of the system. To accomplish this, 6-foot ground rods should be driven, as a minimum, at each generator and at each A- or B-panel. Where rods cannot be driven, they should be laid horizontally in a track about 18 inches deep. The generator's frame ground and system neutral wire must be connected to this ground rod. Ground and neutral wires are connected at each A- or B-panel to a driven ground rod. Further deliberate grounding at other locations is not required.

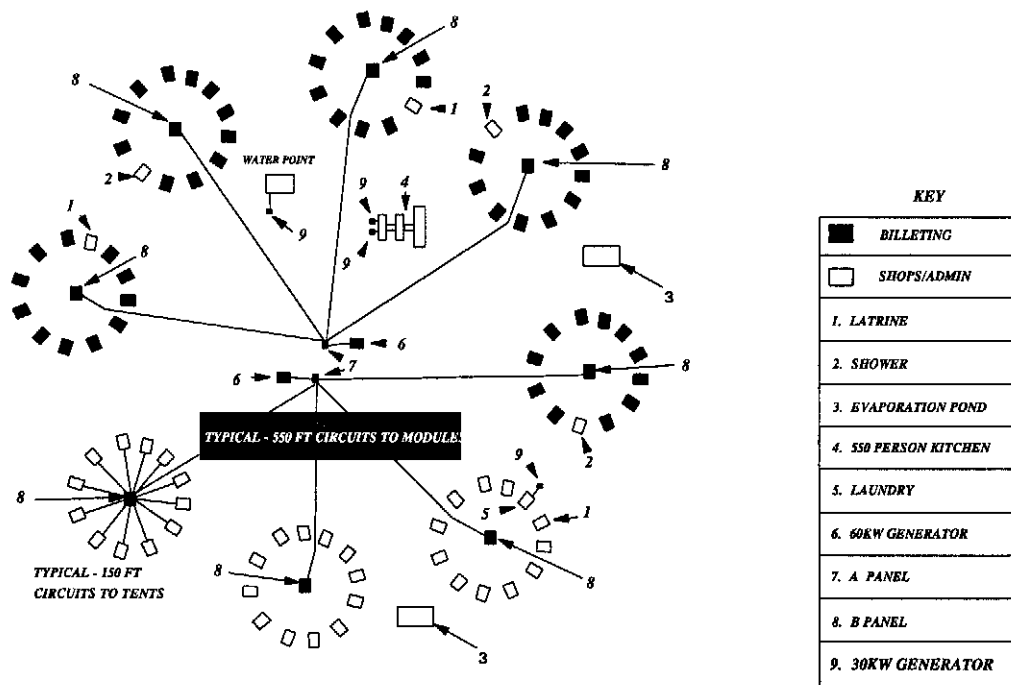
6.4.6. Generators. When not connected to Harvest Falcon SDCs for power, Harvest Eagle modules can be freely dispersed. Each 550-person module group can be powered by either two 60-kW or four 30-kW generator sets. Excluding two 60-kW generators dedicated to the Harvest Eagle airfield lighting system, there are four 5-kW, four 30-kW, and two 60-kW generator sets available as half of a 1,100-person Harvest Eagle package. The recommended distribution of these assets is to use the two 60-kW generators to power the 550-person module group, two 30-kW generators for the kitchen, one 30-kW generator for the laundry, and one 30-kW for the Reverse Osmosis Water Purification Unit (ROWPU). If the ROWPU is located within 400 to 500 feet of the laundry, both units can be powered by a single 30-kW generator. The four 5-kW generators can serve as standby power for communications and tower equipment, NAVAIDS, and similar mission essential operations. As stated earlier, the Harvest Eagle airfield lighting set (if deployed) will require both 60-kW units dedicated to that system. The Harvest Eagle electrical distribution concept for a 550-person bare base is illustrated in figure 6.3. Once the generators supporting the Harvest Eagle system are all on-line, a dedicated crew of power production/ electrical personnel will be required for generator operations and maintenance. Running up to twenty or so generators for each 1,100-person Harvest Eagle increment will be a manpower intensive operation. Engine failures and breakdowns will probably occur and response and repair times will lengthen due to field conditions and perhaps primitive environment. Fueling of these generators will be a constant task since typical day tanks must be refilled approximately every six to eight hours. Ideally, refilling of generators should be accomplished using a refueling vehicle, but under contingency conditions you may have to resort to towed fuel trailers or even jerry cans.

6.4.7. Power Distribution Panels. The power distribution panels (A and B) are used, as mentioned earlier, to subdivide and distribute the generator's power. Both panels are portable and rugged in design. Quick to assemble and safe to operate, both panels can handle voltages up to 240/416. Each panel is protected in a weatherized enclosure. The panels are compatible with the 463L Materials Handling System and can be stacked during shipment.

6.4.8. Tent Lighting and Power Distribution System. The tent lighting and power distribution system consists of three major components: a distribution box, a convenience outlet assembly, and an incandescent light streamer assembly. The lightweight, molded distribution box has a single-pole toggle switch to control the lights and a 20-amp circuit breaker to protect both light and outlet circuits within the tent. Each tent receives two light streamers (3 lights per streamer) and two convenience outlet assemblies (one assembly for each side of the tent).

6.4.9. Future Harvest Eagle Utilities Package. Experience has shown that in some regions of the world air conditioning is required to ease acclimatization, provide proper longer term living conditions, and maintain troop morale. As mentioned earlier, the existing Harvest Eagle electrical system depends solely on the use of low voltage generators. This low voltage system is not sized to accept this additive air conditioning load; therefore, an alternative has been developed. A Harvest Eagle utilities package containing 750-kW generators, PDCs, SDCs, fuel bladders, high and low voltage cables, and air conditioners is being considered. Four of these packages will be stored at Holloman AFB, New Mexico, and deployed with the basic Harvest Eagle sets when air conditioning is required. To date, however, this additive utility package has only been authorized but not funded.

Figure 6.3. Harvest Eagle Electrical Distribution System.



6.5. Harvest Falcon Electrical System. The Harvest Falcon electrical system is basically composed of three major components: generation, high voltage primary (4,160-volt) distribution, and low voltage secondary (120/208-volt) distribution.

6.5.1. Power Generation. In most cases primary power will be obtained from 750-kW diesel driven electric generator sets providing 3-phase, 4,160-volt, 60-cycle power (figure 6.4). Each set comes complete with switch gear controls and output power conductors (high voltage). Each set is fully enclosed with weatherproof access panels to all areas. Each set is capable of operating under autonomous local or remote control. Units may also be operated in multiples of two or more under local or remote control. Each generator is towable by most bare base vehicles and is air transportable on C-130 aircraft. Three generators are required to provide power to the Harvest Falcon housekeeping set. A fourth generator is required to provide periodic maintenance capability. When the Harvest Falcon industrial package is added, a fifth generator is required to provide power for shops. In the most basic configuration, all generators are tied together at a single power plant location to provide electrical output to the bare base electrical distribution grid consisting of a number of individual branch circuits supplying electricity to the user. In a more ideal situation, generators are tied together in a closed loop system which provides two paths of power flow to the connected loads. The closed loop system can be configured in two layouts: a centrally located plant or dispersed plants. In the central plant configuration, the E-G sets and primary distribution centers are at one location. In the dispersed layout up to three "slave" plants are tied to the "master" plant by dual feeder connections fed through a PDC. These tie feeders normally carry less than half of one generator's power capacity (approximately 350 kW). Radiating from the central and slave plants are feeders providing power to SDCs. Backup low voltage, mission essential power can be provided by EMU, MB, or MEP series generators. Power plant layouts for various bare base populations are shown in attachment 5. Included within the Harvest Falcon asset deployment echelons are a limited number of rotational generators which are incorporated into the power plants. These generators permit routine maintenance to be performed on all units on a preplanned basis without having to purposely shut down major portions of the base electrical system. Also supporting the power generation system as part of the Harvest Falcon deployment package is a predetermined set of spares and expendables used for performing required maintenance and routine operations.

Figure 6.4. 750-kW Generator.



6.5.2. Primary Distribution System. The primary distribution system controls and transmits 4,160 volts of AC power from the generators to the secondary distribution system. It consists of the primary distribution center (PDC), primary distribution cables, and primary cable reel pallets. Power is fed from the generators to the PDC (figure 6.5) via 5 kV insulated conductors (figure 6.6). The PDC is a high voltage switching station that serves as a means of separating the high voltage into individual circuits and distributing it throughout the system. The PDC also provides on-off control for the output feeder circuits. Up to four 750-kW generators can be connected to a single PDC. PDCs are typically connected to generators, but they can also accept commercial power at 4,160 volts, 3-phase, 50-Hz. A single PDC has six 3-phase, 200-amp output feeders to provide power to secondary distribution centers (figure 6.7). From the PDCs, power is transmitted over #1/0 aluminum, 5-kV, XLP (cross linked polyethylene) feeder cables. The primary cables are single conductors with a concentric neutral and are provided on reels of 3,000 feet each. There are three reels per pallet (figure 6.8) for a total of 9,000 linear feet of primary cable. Therefore, each pallet provides enough cable to make a distribution run of 3,000 feet.

6.5.3. Secondary Distribution. A secondary distribution center (SDC) (figure 6.9) contains a distribution transformer which steps down the 4,160 volt primary to 120/208-volt, 3-phase, 60-Hz, 5-wire secondary distribution. The SDC is capable of accepting power directly from a PDC or as a loop feed from another SDC. A manual transfer switch enables the SDC to accept power directly from a mission essential power generator, or commercial power, by disconnecting from the base source to the alternate source. Therefore, in the case of a primary power failure the SDC can accept power from any 120/208-volt, 3-phase, 60-Hz source including the EMU, MB, or MEP series generators. A word of caution: the standby secondary power generators may remain connected to the SDC while the 4,160-volt power source is connected and active but the emergency transfer switch should not be operated under load (figure 6.10).

Figure 6.5. Primary Distribution Center.

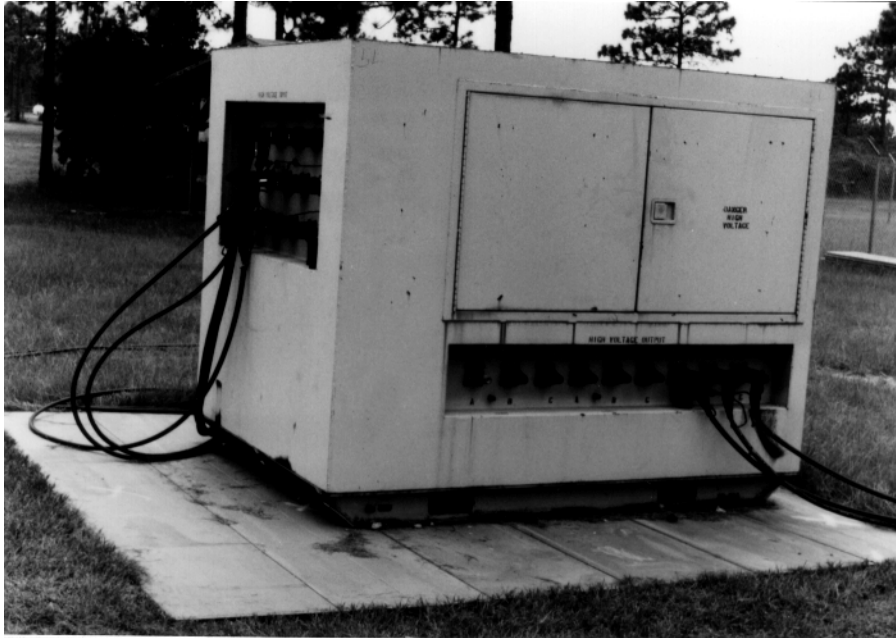


Figure 6.6. 750-kW Generator Conductor Connection.

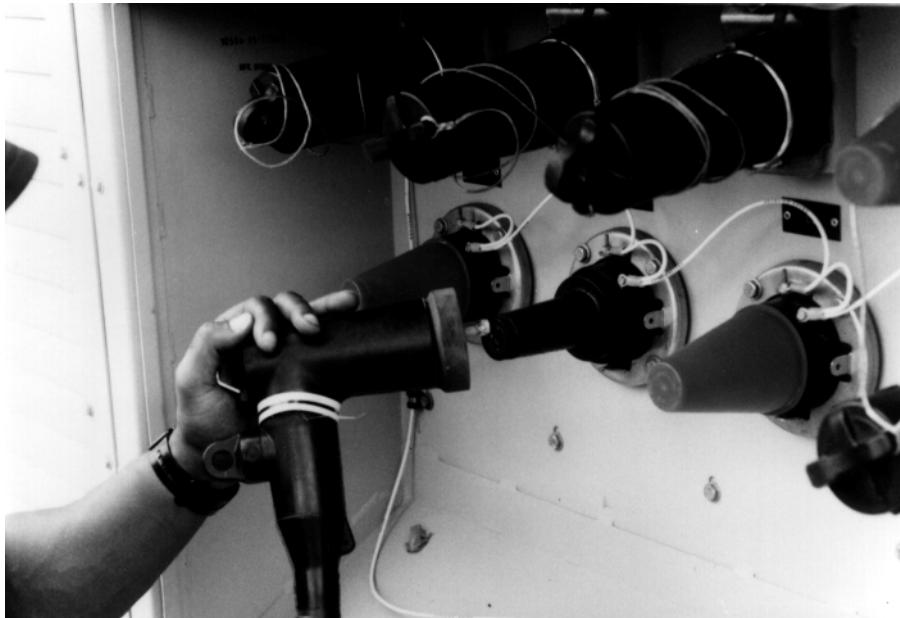


Figure 6.7. Primary High Voltage Generation System.

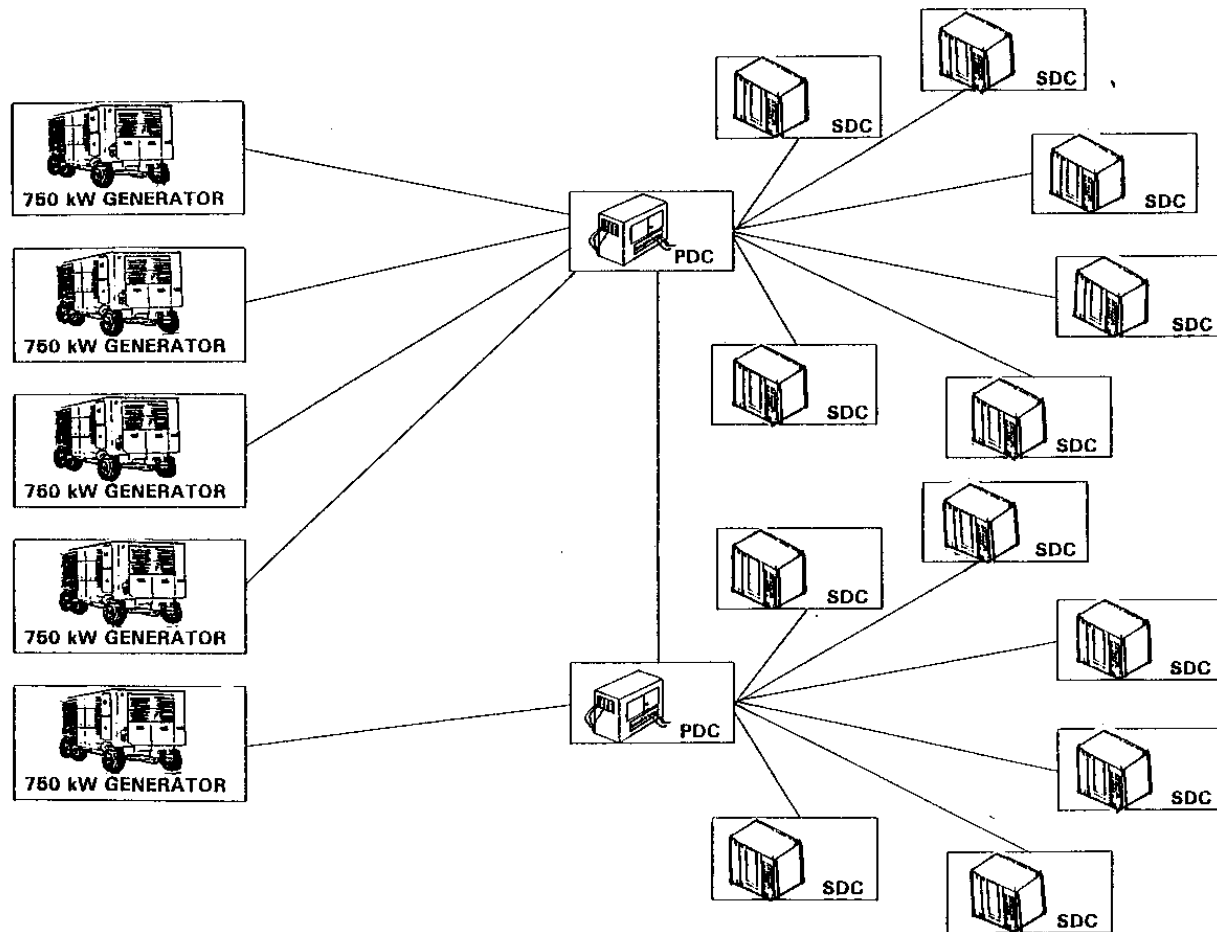


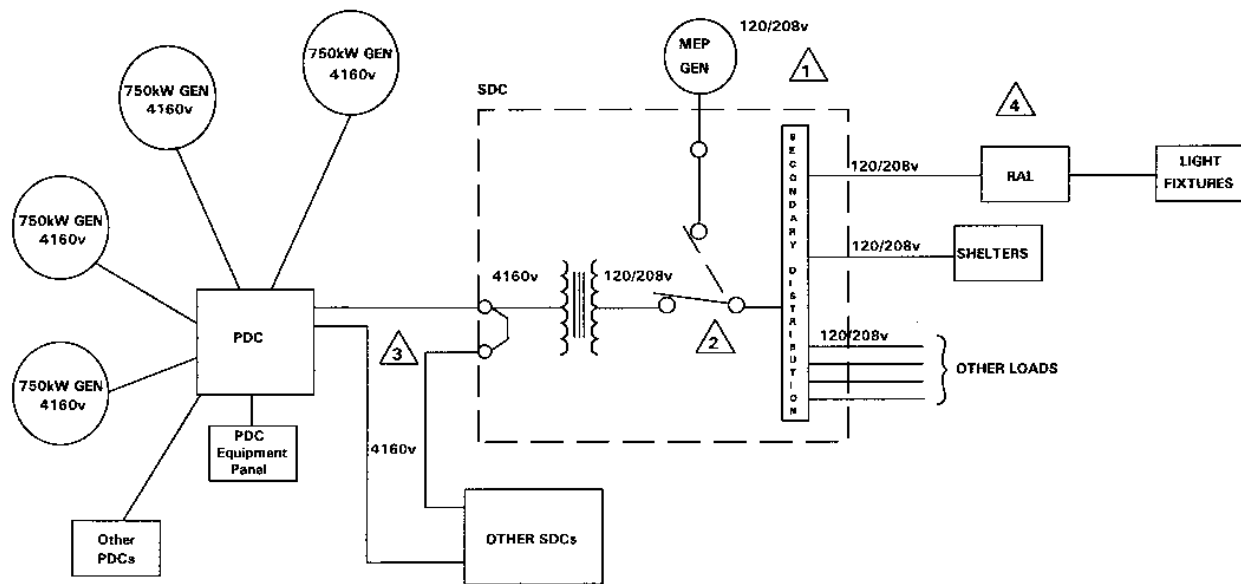
Figure 6.8. Palletized Cable Reels.



Figure 6.9. 150 kVA Secondary Distribution Center.



Figure 6.10. Power Distribution Schematic.



NOTES:

- △1 MEP = MISSION-ESSENTIAL POWER GENERATOR ON STANDBY
- △2 MANUAL TRANSFER SWITCH FROM PRIMARY MEP GENERATOR
- △3 PRIMARY FEED THRU-TAPS ARE AVAILABLE
- △4 ONLY TO BE USED AT THE DISCRETION OF THE COMMANDER OR AT POWER PLANTS (REMOTE AREAS)

6.5.3.1. The SDC also has a secondary distribution section which consists of circuit breakers feeding "Cannon" type connectors which permit connecting the secondary cable feeders (figure 6.11) which in turn feed out to the load centers (electrical distribution panels, figure 6.12) in the various facilities (figure 6.13). These feeders are referred to as the secondary cable assemblies. The Harvest Falcon electrical package contains twenty 150 kVA SDCs in the housekeeping package, another four SDCs in the industrial package, eight in the initial flightline package, and four in each follow-on flightline package.

Figure 6.11. Secondary Cable "Cannon" Connections.



Figure 6.12. Facility Electrical Distribution Panel.

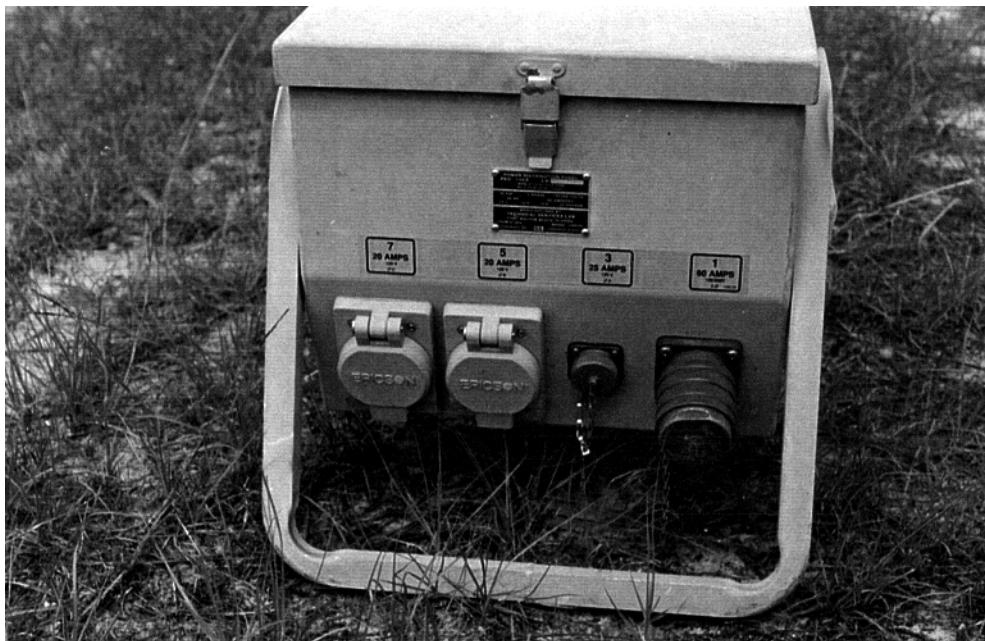
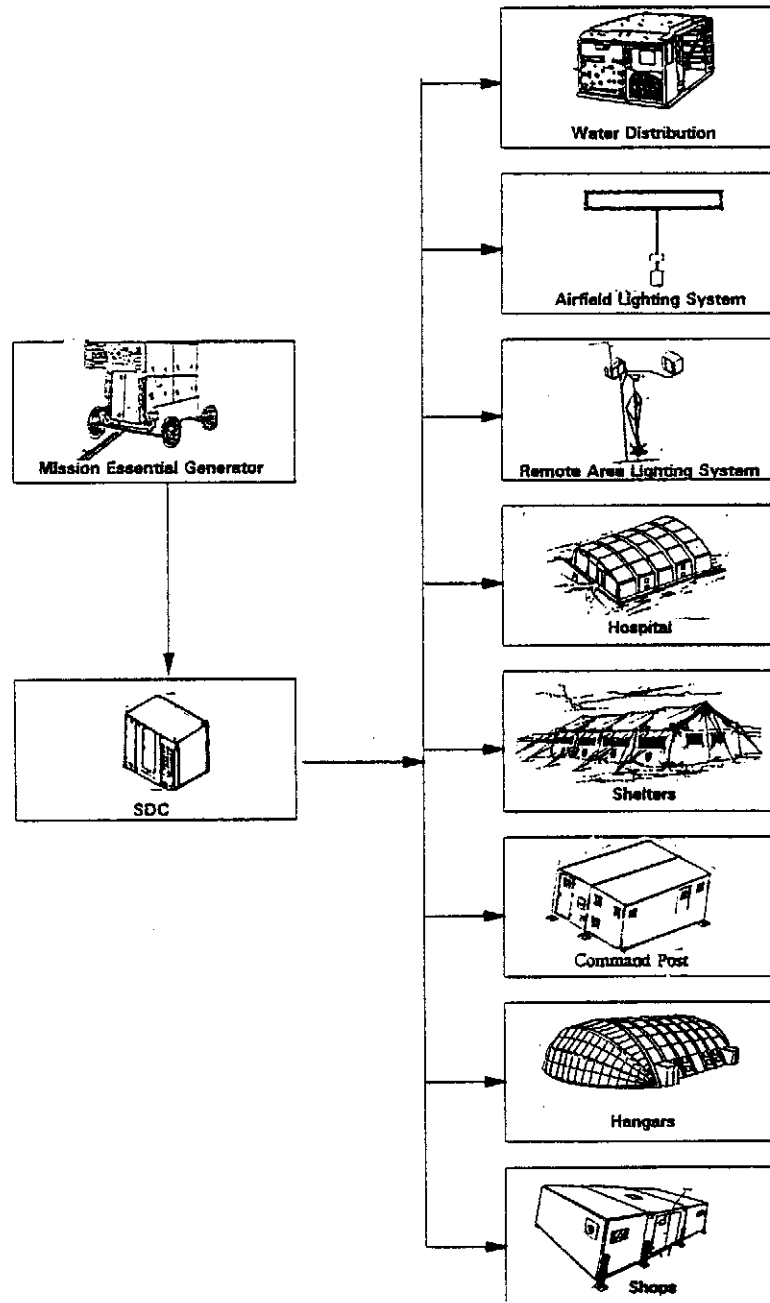


Figure 6.13. Secondary Low Voltage Distribution System.



6.5.3.2. Each SDC has 16 output circuits, each capable of supplying 60 amperes per phase, continuous load, to any load. The secondary feeder cables are 5-wire, #6 AWG copper wires, with 600-volt THW insulation, and an ampacity rating of 60 amperes at 75 degrees Fahrenheit. Storage space is provided for four 100-foot and two 50-foot lengths of MEP cable assemblies which come with the SDC. It is recommended that secondary runs not exceed 800 feet in length.

6.5.4. Installation. The following procedures are for the power generation and the primary and secondary distribution systems for a fully air conditioned concept.

6.5.4.1. Generator Plants. The controls for the generators are normally assembled on a panel located inside of an expandable shelter container or TEMPER tent. Plan on manning generator plants around-the-clock with at least a two-shift operation. Electrical personnel can augment power production personnel in this regard. Plan on providing a generator training program for personnel not fully familiar with the operation of the 750-kW units.

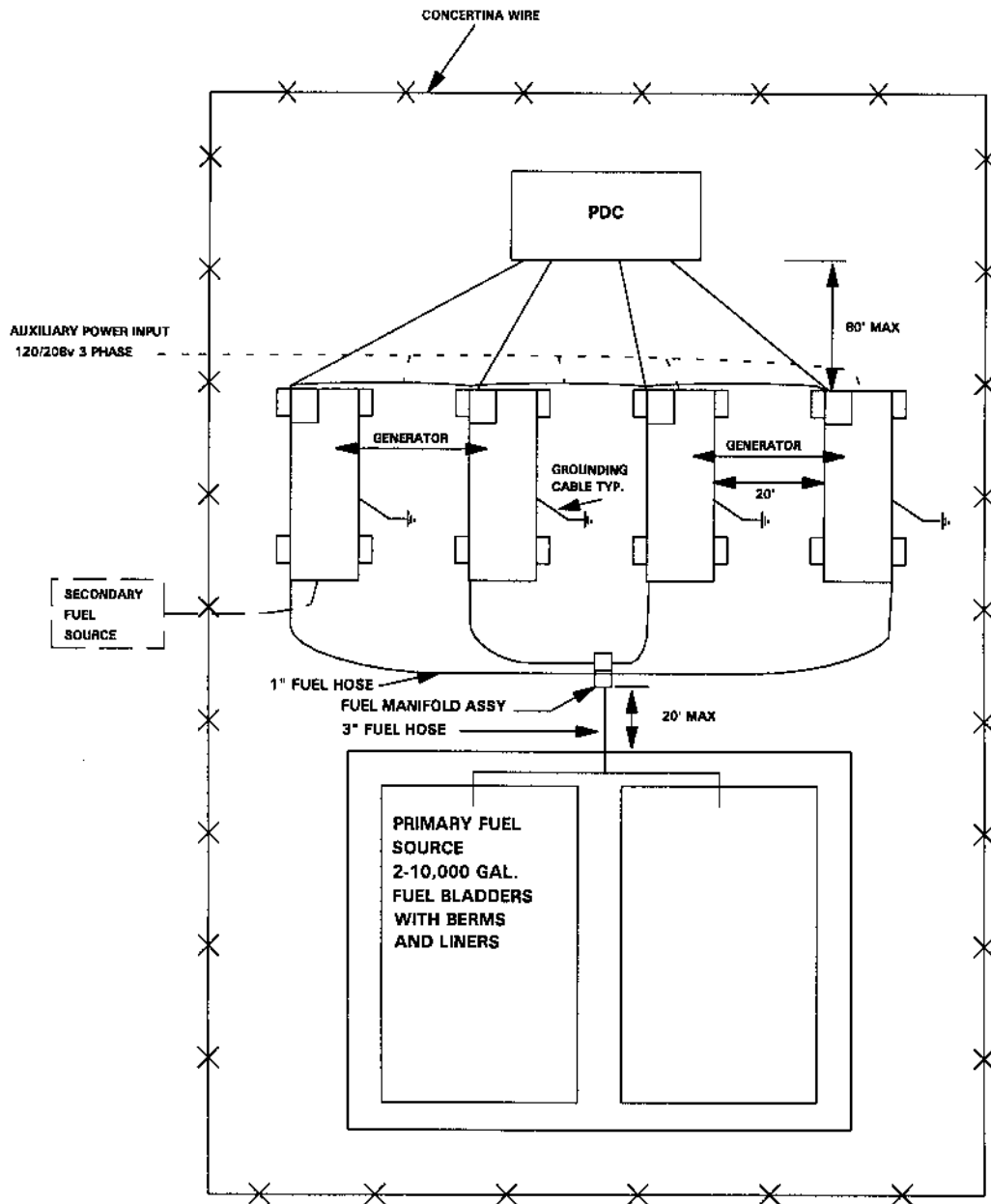
6.5.4.2. Generators. Wind-blown hot air from one engine-generator set can cause a rise in the operating ambient air temperature for another nearby engine-generator set. This higher temperature can cause engine overheating, reduce time between failures, and may require derating of generator output. Avoid such problems by following these recommendations for generator installation:

6.5.4.2.1. Locate engine-generator sets as far apart as feasible, consistent with other requirements. Place at least 20 feet between sets to aid cooling (figure 6.14).

6.5.4.2.2. Place engine-generator sets on a line perpendicular to the prevailing wind direction.

6.5.4.2.3. Avoid placing engine-generator sets in direct sunlight, if possible. A shelter may have to be provided to shield units from the sun.

Figure 6.14. Generator Site Layout.



6.5.4.2.4. Do not attempt to bypass the thermal control, since excessive temperature can cause catastrophic damage.

6.5.4.2.5. Where possible, reduce the effects of blowing sand and dust. Once again, a shelter is in order.

6.5.4.3. Power Distribution. The maximum allowable current in cables is influenced by high ambient temperatures. Heat buildup within current carrying conductors will not dissipate rapidly in high temperature environments. Hence, current carrying ability of conductors must be reduced when installed in areas of high ambient temperature, since an excessive increase in cable temperatures will cause insulation failure. The national electric code begins derating cables at 86 degrees Fahrenheit (30 degrees Centigrade). Protective devices - such as fuses, fused cutouts, time delay fuses, circuit breakers, and motor control contactors - are also affected by these high ambient temperatures. Additionally, sand and dust tend to build up in these electrical components causing operational problems. Finally, the standard methods for power plant or distribution system grounding will not offer adequate or safe grounding because of the extremely poor electrical conductivity of sand, sandy soils, or rocky soils when dry. Therefore, the following installation guidelines are recommended for an arid desert environment:

6.5.4.3.1. Bury primary distribution cables to a depth of 18 inches, if possible. When portions of secondary cables are buried, they should be to a depth of at least eight inches. Cables may be placed in common trenches with raw water or sanitary lines. Install weather tight enclosures over electrical termination devices, where practical.

6.5.4.3.2. Bare base secondary cable assemblies (figure 6.15) come in 60- and 200- amp sizes. There is a mixture of either 4-wire, #6 conductor with ground, 5-wire, #6 conductor, or 4-wire, #4/0 conductor with ground. The 60-amp cables come in lengths of 25, 50, and 100 feet; these are used to connect shelters or electrically operated equipment to the SDCs. One 200-amp cable is 25 feet long and is used to connect the low voltage generator to the SDC. One 200-amp cable comes with each 60- and 100-kW MEP generator. Some of the 60-amp cables are stored with the using shelters or equipment. Cable quantities are contained in attachment 6.

6.5.5. Generator Fuel System. One 10,000-gallon fuel bladder is provided for up to two of the 750-kW diesel E-G sets (figure 6.16). The objective is to have approximately a 7-day fuel supply at each generating plant. When generators and fuel bladders are located near other base facilities, berms should be constructed as shown in Volume 8 of this publication series.

Figure 6.15. Secondary Cable Assembly.

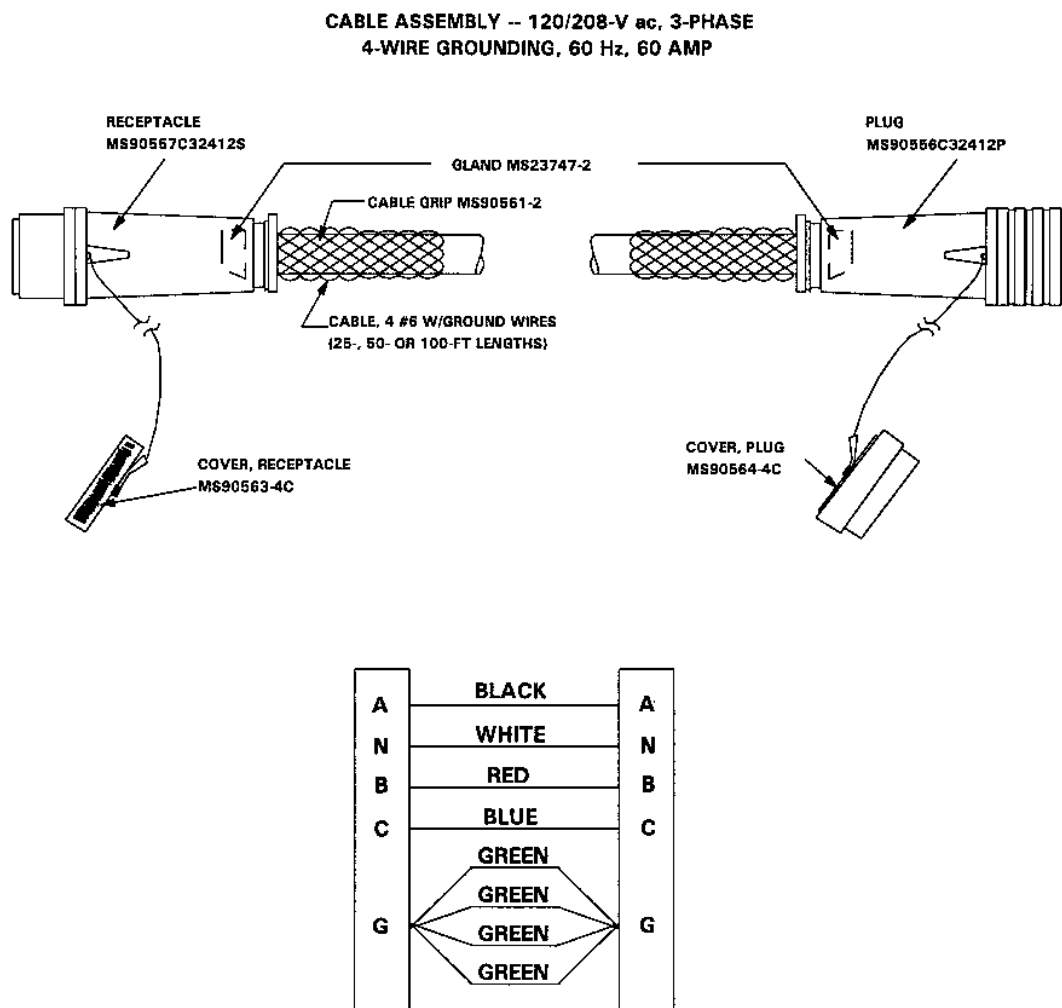
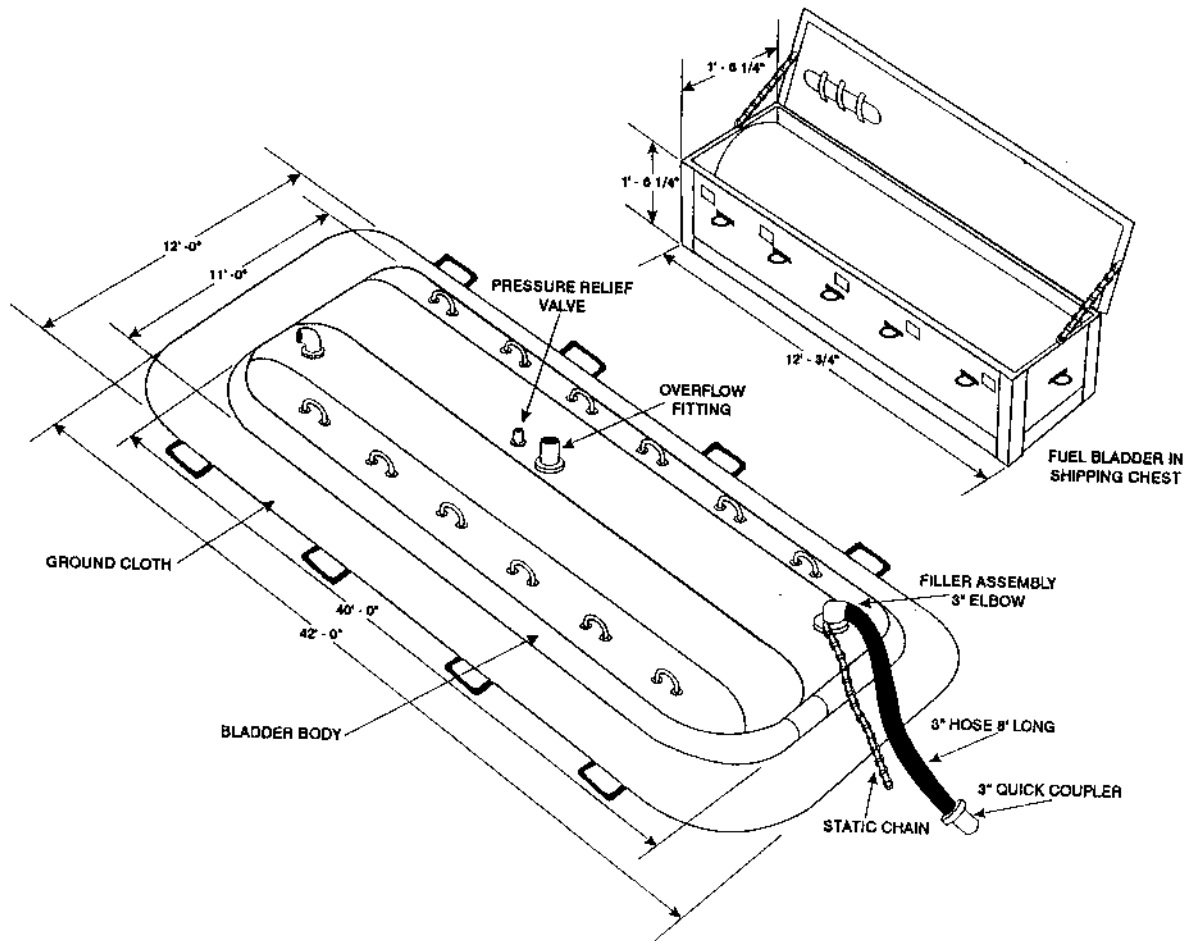


Figure 6.16. 10,000-Gallon Fuel Storage Bladder.



6.5.6. Electrical Computation. The layout of facilities in this document is based on obtaining maximum dispersal compatible with the electrical distribution system assets available in the bare base equipment package. In the event your deployment is to a low threat area where maximum dispersal is not required, minimum spacing distances may be used between facilities. This nondispersed pattern will reduce cable requirements considerably. In contrast, however, when major deviations from this document are necessary due to terrain features of other constraints, it may be necessary to have a sufficient stock of extra MEP cables of different lengths so that some secondary circuits can be extended (MEP cables will plug into each other similar to extension cords). Exercise caution by not extending any individual branch circuit beyond the point where the cable will have a voltage drop greater than 10 percent. As a rule of thumb, limit the maximum length of any secondary branch circuit to roughly 700 to 800 feet.

6.5.7. Electrical Planning. Attachment 7 of this publication contains a compilation of the power requirements for each element within a facility group, presents example feeder schedules, and also shows schematics of a typical bare base electrical distribution system. The feeder schedule provides examples of the various electrical loads of different SDCs, method of supplying power to air conditioners, and mission essential power, where necessary.

6.5.7.1. Each facility group is sub-divided to define the particular buildings served by each SDC. A mission essential generator can be connected directly to all SDCs. This capability allows for providing power to essential facilities and equipment during base buildup and also provides a backup capability for essential facilities once primary power is installed.

6.5.7.2. Cable lengths are based on the shortest distance between two points plus 10 percent, run on the surface of the ground, and with no allowances made for extreme variation in ground elevation.

6.5.7.3. Power requirements for some facilities can be satisfied by running power from an adjacent shelter exterior receptacle, by fabrication of a junction box to service one or more of the facilities simultaneously from one 60-amp connector on the SDC, or by using the generator on a TF-1 or similar lighting unit (figure 6.17), if power is required in remote areas of the base. If power is drawn from the TF-1 light unit, the output is limited to about 5 kW.

6.5.7.4. Computation of electrical feeder loads was accomplished using data from shelter configuration agencies and applying appropriate diversification factors. All loads are 3-phase. The total load for each SDC was determined by first adding all the shelter loads; second, diversifying this total by multiplying by seven tenths (0.7); and last adding either the heater or air conditioner loads, whichever is larger (the heater and air conditioner should not run simultaneously). The resulting load is the total kVA load on the SDC. If you need a quicker way to estimate your requirements, then figure one SDC per every eight to twelve facilities.

Figure 6.17. Floodlight Set.



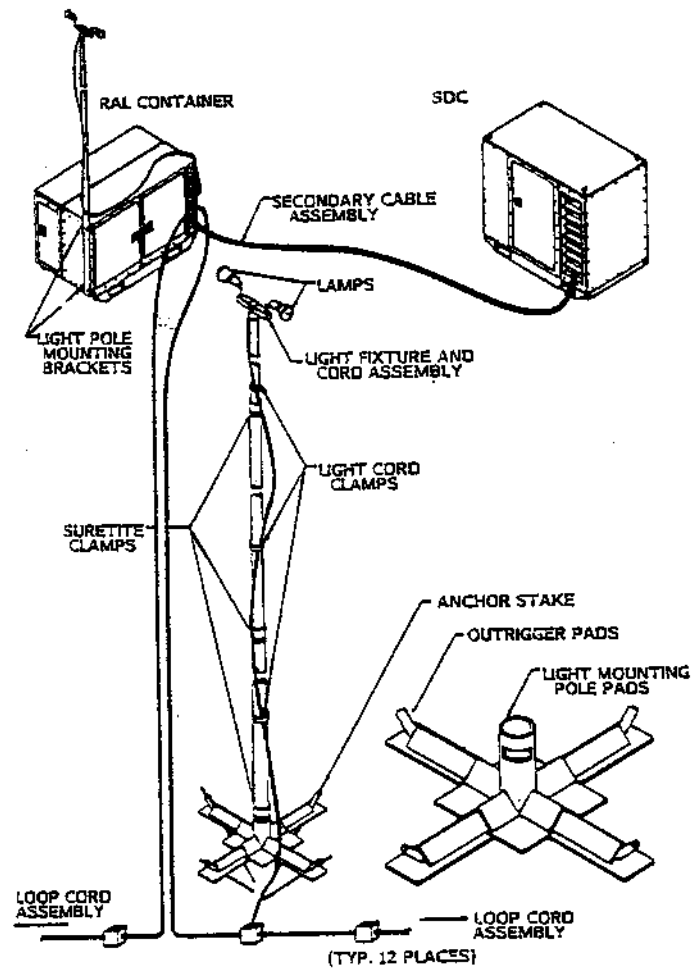
6.5.7.5. Area lighting (flight line, supply areas, aerial port facilities) can be accomplished using remote area light (RAL) units (figure 6.18). RALs depend on power from an SDC or other source such as a remote area generator.

6.5.7.6. Water purification plants are shown on the base layout plan. Once these plants have been sited, an electrical installation team will determine exact locations of SDCs and MEP generators which support the water plants.

6.5.7.7. Sewage lift stations and treatment plants are indicated on the base water and sanitary layout plans. Electrical power must be provided from the nearest SDC.

6.6. Grounding. In any electric power generation and distribution system, appropriate electrical grounding of equipment such as generator sets, transformers, junction boxes, and bus bars is generally very important to ensure safe and reliable operation of the system. Traditional guidance requires 25 ohm resistance to ground, or less, at all normally grounded locations. However, the nature of the soils in many locations will not permit this level of assured grounding with traditional ground rods or expedient techniques. In especially dry, rocky, or sandy regions, 25 ohm or less grounding to earth can only be obtained using more involved and equipment-intensive methods that may not be available to bare base engineers. Attachment 8 discusses grounding methods that are available to you and your field engineers, and that will provide "adequate by expediency" grounding levels consistent with both time phasing of base camp construction and the distribution system used.

Figure 6.18. Remote Area Lighting Unit.



WATER UTILITY SYSTEMS



7.1. Introduction. In bare base operations, water is not everything; it is the only thing. That is why it is absolutely essential that a source of water which can be made potable is available before consideration is given to other requirements.

7.2. Overview. The sources, uses, treatment, and distribution of water are addressed in quite some detail in this chapter. Water supply in arid and non-arid environments will be discussed. Since water is generally very scarce in an arid environment, it must be used wisely. Consequently, a large part of this chapter will be devoted to describing proper water supply and use in the context of a worst case situation - a bare base located in an arid environment.

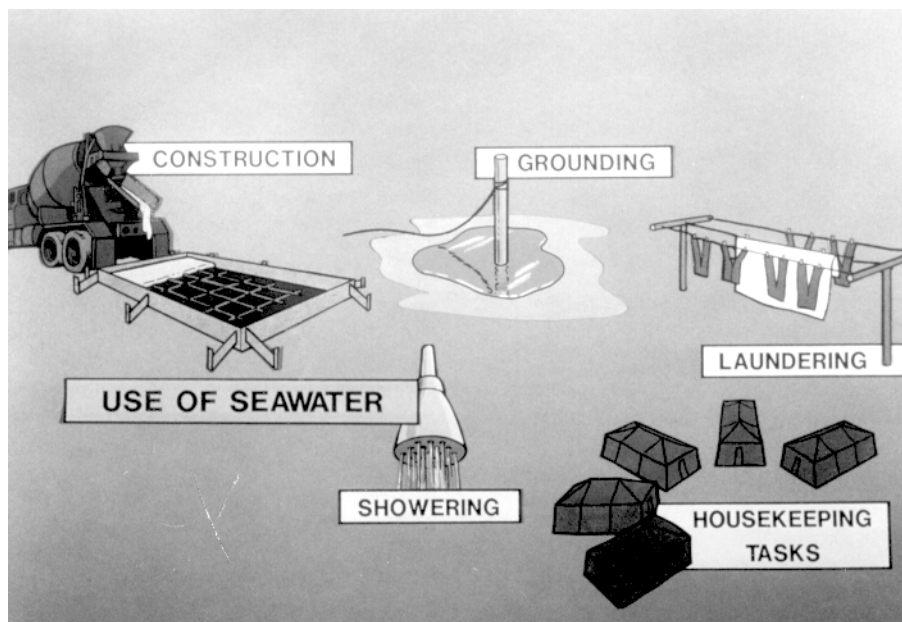
7.3. Sources.

7.3.1. Non-Arid Environments. In non-arid environments water is generally readily available. Streams, rivers, and lakes abound. The water usually requires only clarification and disinfection to make it potable. Groundwater is also abundant. Many times the only treatment groundwater requires is disinfection. However, groundwater near industrial areas should be tested for the presence of hazardous wastes. All water must also be examined for the presence of human waste.

7.3.2. Arid Environments. The single most important characteristic of arid areas is the lack of water. Surface water is limited to a very few rivers and intermittent streams that benefit from the sparse rainfall. Except for limited areas, primarily along the coast, groundwater is also scarce and is generally unfit to drink because of the dissolved solids content. Because of the widespread unsanitary practices, all water in underdeveloped countries, no matter what the source, should be considered to be contaminated with disease causing organisms until proven otherwise. As a result, a contingency force must be prepared to produce its own potable water from any available source, and must constantly strive to conserve this mission essential resource, regardless of the water's quality and ultimate use.

7.3.3. Seawater. Seawater obtained offshore at a location removed from a sewage outfall is normally relatively clean. It is very salty and contains suspended particles of sand and bacteria. Seawater may be used without adverse effects for electrical grounding, housekeeping tasks, firefighting (not in fire vehicles), some construction tasks, showering, and laundering (figure 7.1). It should not be used where continued use could corrode critical metal surfaces. When used for showers, laundries, and personal hygiene purposes, it must be disinfected.

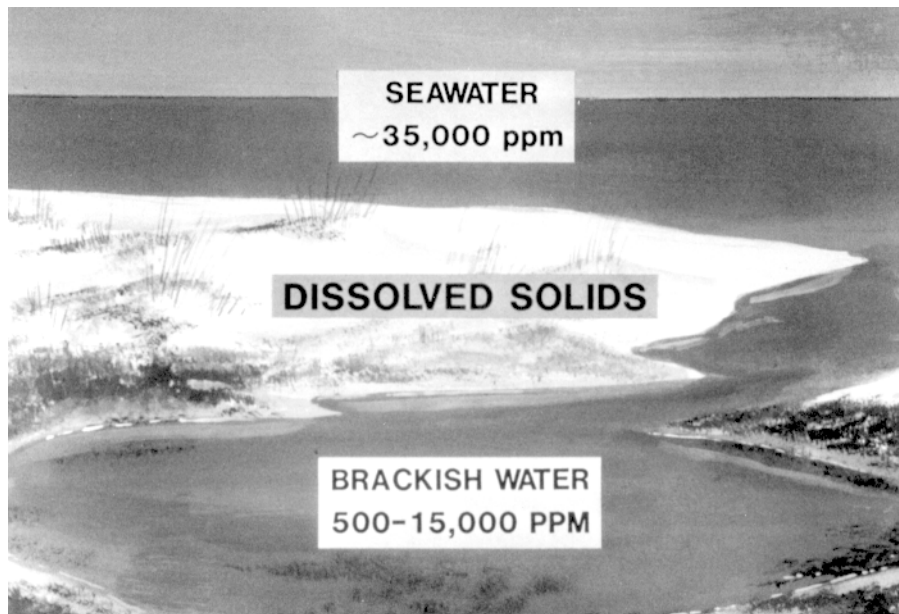
Figure 7.1. Uses of Seawater.



7.3.4. Brackish Water. Surface water and groundwater containing 500 to 15,000 parts per million (ppm) of dissolved solids is called brackish. The solids content is much less than seawater (35,000 ppm), but is high enough to give the water a distinctively salty taste (figure 7.2). Brackish water may contain dissolved salts which make the water difficult to lather (forms curds) and, when heated, leaves hard mineral deposits on the wetted surface of the container. As with seawater, brackish water may be used for construction, electrical grounding, firefighting, and general housekeeping tasks. It is not generally recommended for those purposes where it is to be heated to near boiling temperatures. Additionally, some aquifers may be contaminated by oil. Other less common contaminants such as ammonia, arsenic, and radioactive isotopes may be encountered.

7.3.5. Freshwater. Freshwater (less than 500 ppm of dissolved salts) has no apparent salty taste, but when found on the surface (river, stream, oasis) may contain suspended materials, dissolved minerals, fecal matter, bacteria, and other disease-causing organisms. When obtained from local wells or the municipal water supply systems, freshwater may appear clean with no significant odor. Despite its appearance, such water sources may contain dissolved minerals, salts and bacteria. Disinfection through chlorination is often the only treatment required to make the local water drinkable. On the other hand, drinking freshwater containing significant amounts of dissolved salts may produce a laxative effect.

Figure 7.2. Dissolved Solids in Brackish Water and Seawater.



7.3.5.1. Freshwater can be used for most cleaning and nonconsumptive purposes without purification. Conventional water purification procedures are normally adequate to make most freshwater sources potable; however, when the dissolved solids content is too high, water should be purified by reverse osmosis treatment. To reemphasize a point made earlier; do not make the mistake of assuming that a particular municipal water supply is safe. Some countries do not treat water to the standards required by the Air Force. To safeguard the health of the deployed forces, indigenous water sources must be tested before being declared suitable for human consumption.

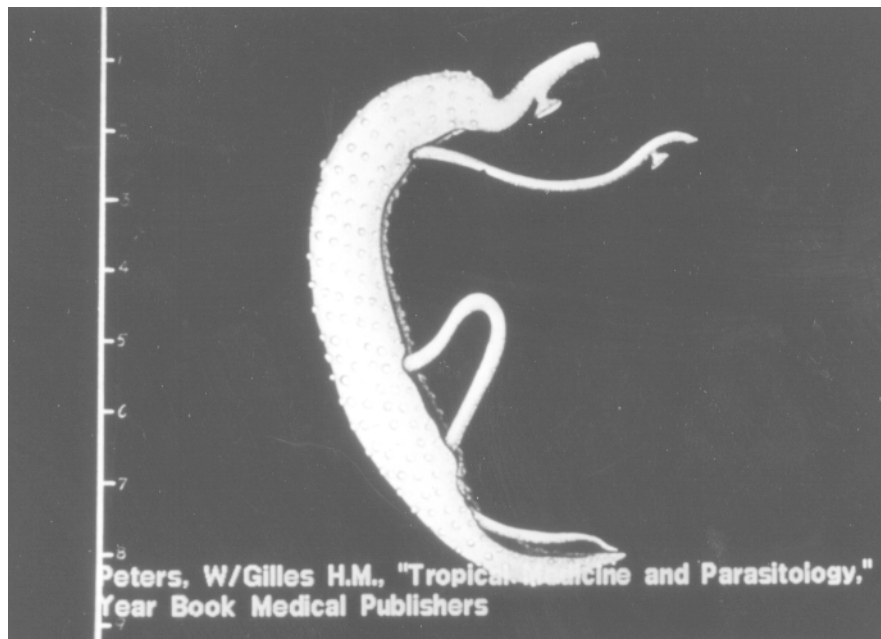
7.3.5.2. Surface freshwater sources can also be a major health hazard. These waters, primarily rivers, often serve the indigenous population for the disposal of all forms of wastes (including human waste) and for that reason are a source of pathogenic organisms. Surface freshwater also harbors a variety of other organisms which may infect humans through bodily contact with the water (figure 7.3).

7.3.5.3. Drinking water from a source such as depicted above is obviously dangerous. Even more health-threatening are the blood flukes, small worms spawned by several types of snails, that cause a disabling disease known as schistosomiasis. Prevalent in Africa and Southwest Asia, these immature worms (schistosomes, figure 7.4) are released from the snail's bodies into the water. The worms penetrate the skin of people who are in the water to bathe, swim, or do their laundry. Once in the body, these worms block circulation and cause scarring in the liver, bladder and intestines, giving rise to severe swelling. Schistosomiasis can occur in less than 30 days. Treatment for this disease is very painful, and to make matters worse, there is no vaccine for schistosomiasis.

Figure 7.3. Contaminated Surface Freshwater Source.



Figure 7.4. Schistosomes.



7.4. Water Use. When mobile water treatment and distribution assets are used, the water use planning factor is 20 gallons per person per day (gpd). If a permanent water treatment plant is available at a beddown location, however, a 50 gpd factor may be used. A breakdown of the 20 gpd planning factor is shown in table 7.1. Some functions can be met with potable water only. Some can be accomplished with either potable or nonpotable water. A description of each of the factors follows as well as a discussion of ice requirements.

Table 7.1. Water Use Planning Factors.	
FUNCTION	WATER USAGE FACTOR (gal/person/day)
Potable Water	
Drinking	4.0
Personal Hygiene	2.7
Shower	1.3
Food Preparation	3.0
Hospital	1.0
Heat Treatment	1.0
Nonpotable Water	
Laundry	2.0
Construction	1.0
Graves Registration	0.2
Vehicle Operations	0.3
Aircraft Operations	2.0
10% Loss Factor	<u>1.5</u>
TOTAL	20.0

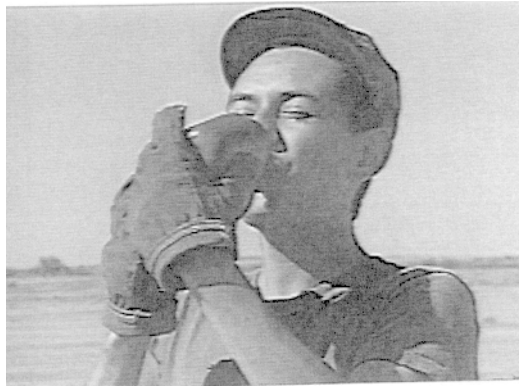
7.4.1. Potable Water.

7.4.1.1. **Drinking.** Approximately 4 gallons of cooled drinking water will be provided each individual per day. Those engaged in strenuous physical activities will normally require this amount of water to maintain their strength during the hottest period of the day. Those who are less active will drink less. Under all circumstances, everyone needs to develop a habit of drinking frequently during the day, whether thirsty or not (figure 7.5).

7.4.1.2. **Personal Hygiene.** Approximately 2.7 gallons of water is to be provided for personal hygiene each day. It is allocated for the following purposes: daily shaving, 1-1/2 quarts or helmet capacity; helmet baths on alternate days, 6 quarts or four helmets; comfort cooling, 1/2 quart over individual's head, eight times a day; brushing teeth and hand washing, 2-1/4 quarts.

- Drink extra water *before* starting any mission or hard work.
- Drink small quantities frequently.
- Drink water even if you are not thirsty.
- Refill your canteens at opportunity.

Figure 7.5. Water Consumption in Hot Climates.



7.4.1.3. Shower. Approximately 4.5 gallons of water are to be utilized twice a week per person for a three-minute shower. There may be occasions when bacterially safe nonpotable water, such as river or stream water, can be used by contingency forces. In these instances, however, approval to use water from rivers and similar sources without treatment should be obtained from the unit medical officer.

7.4.1.4. Food Preparation. The amount of water used for food preparation varies with the type of meal being served. In arid regions two "B" type meals and on "C" type meal will be served daily. Preparation of these meals will require 0.65 gpd. Another 2.35 gpd are required for kitchen cleanup. The total water requirement for food preparation is 3.0 gpd.

7.4.1.5. Hospital. The hospital consumption planning factor is 1.0 gpd. This figure comes from a projection of 65 gallons per day (gal/d) for each patient bed and 10 gal/d per hospital staff member. These rather significant quantities of water are based on daily baths for the medical staff and the majority of patients; changes of uniforms and bedding each day; and the various general sanitation, food preparation and housekeeping tasks accomplished each day in support of patients and hospital staff.

7.4.1.6. Heat Treatment. Approximately 1.0 gpd is planned for use in the treatment of heat casualties. Heat casualties are normally treated by submersion in cool water and by forced intake of liquids.

7.4.2. Nonpotable Water.

7.4.2.1. Laundry. About 2.0 gpd is allocated to launder individual and organizational clothing. Although potable water is not required, you should nevertheless consider the constraints imposed by the use of untreated water. First, hard water not only reduces the cleaning power of laundry detergents, but may also deposit insoluble residue on the clothing being laundered. Second, brackish and saltwater rapidly corrode the metal components of the laundry system. However, both problems can be overcome, or at least tolerated for a short period of time in an austere base environment. Saltwater detergents, developed primarily for shipboard use by the Navy, are available in the DOD inventory. Corrosion tolerance is essentially a trade-off between immediate requirements and increased equipment wear and subsequent maintenance work.

7.4.2.2. Construction. Approximately 1.0 gpd is planned for construction. Concrete mixes for most contingency field applications do not require better than nonpotable quality water. In general, satisfactory concrete can be mixed using natural surface water, brackish water and seawater, or any water that is free of oil and suspended organic matter, especially sugar. Also, sewage effluent that has undergone the equivalent of secondary treatment is suitable for concrete. There may be some occasions to use wastewater as a dust control agent.

7.4.2.3. Graves Registration. Approximately 0.2 gpd is planned for graves registration. This involves the handling of remains, which demands the application of good sanitation practices, especially among the graves registration personnel. Some water is used for washing remains, but most is used for hygiene. Handlers are required to wash and disinfect themselves frequently.

7.4.2.4. Vehicle Operations. Approximately 0.3 gpd is planned for vehicle operations. Water will be used primarily for radiator makeup. Washing of vehicles should be kept to a minimum to prevent water wastage.

7.4.2.5. Aircraft Operations. Aircraft operations will require 2.0 gpd. The water will be used primarily for cleaning engine intakes and to prevent engine damage from ingested sand. Water will also be used to clean other surfaces which could be damaged by abrasion.

7.4.2.5.1. Certain strategic aircraft use a water injection thrust augmentation system. When water is injected into the air intake of a jet engine, it cools the air intake air, which becomes more dense. When air is mixed with the hotter fuel, the result is an improved combustion mixture producing added thrust. Water injection is generally used under heavy aircraft loads and hot weather in certain models of KC-135 aircraft. Additionally, FB-111 aircraft contain an internal environmental control (cooling) system which uses water as the coolant.

7.4.2.5.2. For aircraft thrust augmentation, specifications call for the water to contain no more than 10 ppm total dissolved solids (TDS) and pH of 6.0 to 9.5. In tactical situations, water up to 50 ppm TDS is acceptable. Demineralized water units are normally included in the organizational equipment of user units. If these are not available, however, the Reverse Osmosis Water Purification Unit (ROWPU) may be used. When using the ROWPU, it may be necessary to reprocess the water to lower the TDS until it meets required specifications. The demineralized water consumption rate for KC-135 aircraft is 670 gal/sortie and for FB-111 aircraft, 27 gal/sortie.

7.4.3. Ice Requirements. Hot weather and strenuous physical activity cause body temperature to increase. The body rids itself of heat by evaporation of sweat. This natural cooling system is efficient, and the body continues to function well if its water losses are replaced. When they are not, dehydration takes place, and with it there is a corresponding loss in body function efficiency. If dehydration is allowed to progress, an individual can quickly become incapacitated, and then must be treated for heat stroke.

7.4.3.1. The normal thirst sensation is not a reliable indicator of the water requirement. It will be necessary, therefore, for individuals to drink water frequently during the hot and most active part of the day. It may be necessary to cool the water to at least 70 degrees Fahrenheit (60 degrees Fahrenheit is more desirable) to make it more palatable. If water cannot be sufficiently cooled for consumption, then it is important to alter the taste. For example, kool-aid is palatable at 85 degrees Fahrenheit where water is not. It is assumed that water converted to ice to cool drinking liquids will be consumed and is considered part of each individual's daily allocation.

7.4.3.2. The dining hall will dispense 0.5 gallons of water per person each day as beverage during meals and another 0.09 gallons (12 ounces) per person of water converted into ice to cool that beverage. Dining halls will have their own dedicated ice machines.

7.4.3.3. About half of the base population will perform daily duties away from the areas where drinking fountains are available; therefore, drinking water or beverage must be transported to job sites in 5- and 10-gallon insulated containers. It takes 2.88 gallons of water or beverage person per day to meet these requirements and another 0.53 gallons of water converted to ice (4.4 pounds) to cool the 75 degrees Fahrenheit liquid to a desired 60 degrees Fahrenheit for three to four hours when the ambient temperature is 120 degrees Fahrenheit. See paragraph 7.8.2. for further clarification on ice making operations.

7.4.3.4. The ice needed by medical treatment facilities located at the bare base represents an additive requirement; the quantity of ice to be allocated to each type of medical facility is shown in table 11.5 of chapter 11.

7.4.3.5. Mortuary holding area ice requirements (for graves registration when mechanical refrigeration is not available) are 1.7 pounds per person per day (0.2 gallon of water) in arid climates.

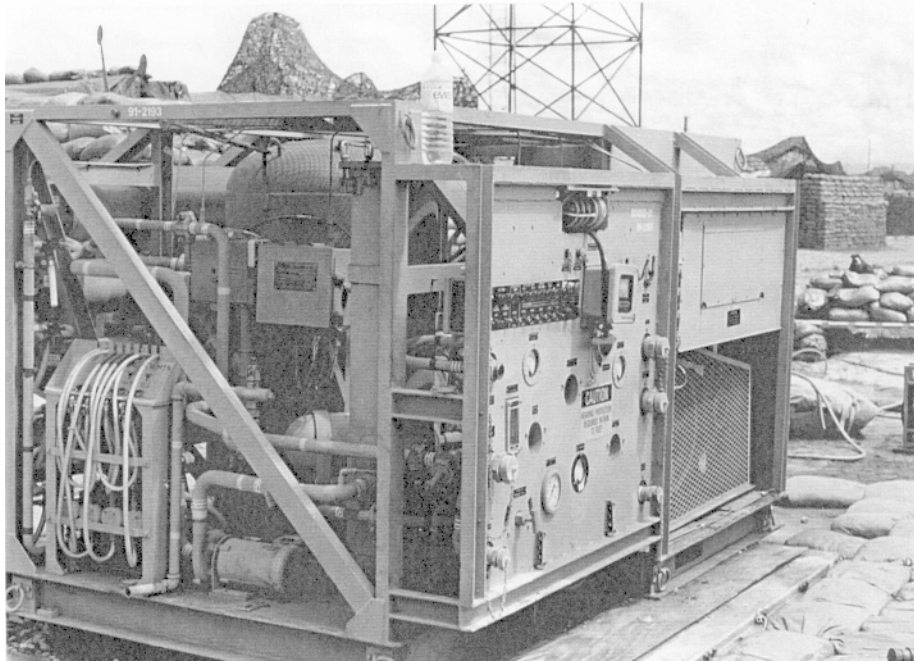
7.5. Water Treatment. The primary water treatment equipment item used in bare base operations is the reverse osmosis water purification unit which can produce potable water from nearly any source of water.

7.5.1. ROWPU. With the formation of the Rapid Deployment Force in the late-1970s, an increased need arose for water purification equipment which could produce potable water from seawater. To meet this need, the 600-gallon per hour (gal/h) ROWPU, able to produce potable water from either seawater or freshwater, was selected. The unit is contained in an 86-inch wide by 81-inch long by 66-inch high frame and weighs 7,300 pounds (figure 7.6)

7.5.1.1. The ROWPU purifies water by first removing large suspended material from the water in a multimedia filter. The remaining suspended material is removed in a cartridge filter. The water is then pumped at high pressure (up to 950 psi) to reverse osmosis membranes. The membranes allow about 1/3 of the water to pass through them. Since very little of the dissolved solids in the water can pass through the membranes, the water that has passed through is desalinated. The dissolved solids concentrated in the water that does not pass through the membranes produce a brine water discharge. The brine water discharge flow is typically twice the product water flow. In other words, if the ROWPU produces 600 gal/h of product water, it also produces 1,200 gal/h of brine water. Over the course of a day at a large water treatment plant many gallons of brine water will be produced. Sometimes this by-product can be put to good use in construction or dust control or stored for fire fighting. Usually, however, more brine will be produced than can be used effectively; therefore, some additional, alternate methods of disposing this waste material must be developed. Considerations might include returning brine to the raw water source, cutting drainage channels allowing brine to be discharged away from base facilities and soak into the ground, or even trucking it out of the immediate area.

7.5.1.2. ROWPUs normally do not come with their own power source. Because of the energy required to pressurize the water for the reverse osmosis process, the ROWPU requires up to 22 kW of electrical power. The lower the dissolved solids content of the water, the lower the power requirement. The 22-kW requirement is based on treating seawater. Brackish or freshwater sources will require less energy.

Figure 7.6. Reverse Osmosis Water Purification Unit.



7.5.1.3. Production capability of the ROWPU is affected by the temperature of the feed water. Very cold or very warm feed water temperatures will decrease the output of the ROWPU and shorten the life of the membranes. When the temperature of the feed water exceeds 95 degrees Fahrenheit, plan on producing less water than usual. The dissolved solids concentration of the raw water also influences the production capability of the ROWPU. Under normal conditions, the ROWPU can produce 600 gal/h of potable water from seawater. However, the production capacity can be affected by the chemistry of the water and at times unique conditions can exist which will lower the capacity of the ROWPU. For planning purposes this publication assumes such conditions will not be encountered frequently and ROWPU production remains at 600 gal/h. It is also assumed that a ROWPU will be normally operated for 20 hours each day. The remaining four hours are allotted for backwashing and scheduled maintenance.

7.5.1.4. In an emergency, the output of the ROWPU can be expanded by increasing the pressure of the water going to the reverse osmosis membranes. The pressure must not exceed 950 psi. Up to 900 gal/h of water can be produced from the ROWPU in emergency conditions. However, operation at higher pressures will shorten the life of the membranes and produce greater stress in all other parts of the ROWPU since they will be operating at higher capacities.

7.6. Water Treatment Plants. When several water treatment units must be used to meet the water requirements of a given base population, the individual units should be consolidated into water treatment plants.

7.6.1. Scope. In low threat areas, where enemy attack is unlikely, one central water plant is most efficient. Less manpower and logistics support are required to operate one plant than two plants that produce an equal amount of treated water. Where an enemy attack is likely, multiple water plants should be established to enhance survivability. The vital need of water at a bare base justifies sacrificing the economy of operation in a high threat area. No more than two water treatment plants are recommended; one should be located near the billeting area, the other near the flightline.

7.6.2. Water Storage. A bare base should have the capability to store a 5-day supply of water. The storage capacity should consist of a 3-day supply of potable water and a 2-day supply of untreated water. At bases using two treatment plants the storage capacity should be fairly evenly split between the two plants.

7.6.3. Plant Layout. A typical water treatment plant schematic is shown in figure 7.7. This single plant represents a treatment complex for a 3,300-person base. Twenty thousand (20,000)-gallon water storage bladders are used to provide the needed storage capacity. If a dispersed plant operation is deemed necessary, two plants could be established similar to those shown in figure 7.8. For operations which require a single ROWPU, the setup in figure 7.9 should be used. Used primarily for exercise support or for fragmented taskings, a single ROWPU can support approximately 600 people and stores a 1-3/4 day supply of potable water. No distribution system is included and the unit must be located at the water source. Water treatment plant layouts for various size bases are shown in attachment 9.

7.7. Mobile Water Systems. The Harvest Eagle and Harvest Falcon water systems represent the two mobility sets used to provide water during wartime and contingency operations. Although Harvest Eagle is the older of the two systems, it has been upgraded over the years and now shares many equipment items and components with the Harvest Falcon system.

7.7.1. Harvest Eagle Water System. The Harvest Eagle water system (figure 7.10) provides a 550-person encampment with a supply of water for drinking, cooking, bathing, and laundry. This system, designed for worldwide deployment, includes water treatment, storage, distribution, and freeze protection. It also includes a very basic wastewater disposal system to rid gray water from bivouac areas. Multiples of this system can be used to support larger deployments. The system is air transportable in C-130, C-141, and C-5 aircraft; it is compatible with the 463L Materials Handling System.

7.7.1.1. Water Treatment. The ROWPU is used as the water treatment unit for the Harvest Eagle water system. A chlorinator is also used for further disinfection of the water. Two ROWPUs are included in the basic 1,100-person Harvest Eagle set.

7.7.1.2. Water Storage. The water storage in the Harvest Eagle system is accomplished using two 10,000-gallon bladders (normally positioned at the treatment plant), three 400-gallon water trailers (figure 7.11), eight 3,000-gallon onion tanks (figure 7.12) and two 500-gallon onion tanks. Smaller quantities of water can be stored in 36-gallon lyster bags and 5-gallon igloo water coolers. In all, there are approximately 50,000 gallons of water storage capability which equates to a 5-day supply for a 550-person contingent.

Figure 7.7. Typical Water Treatment Plant.

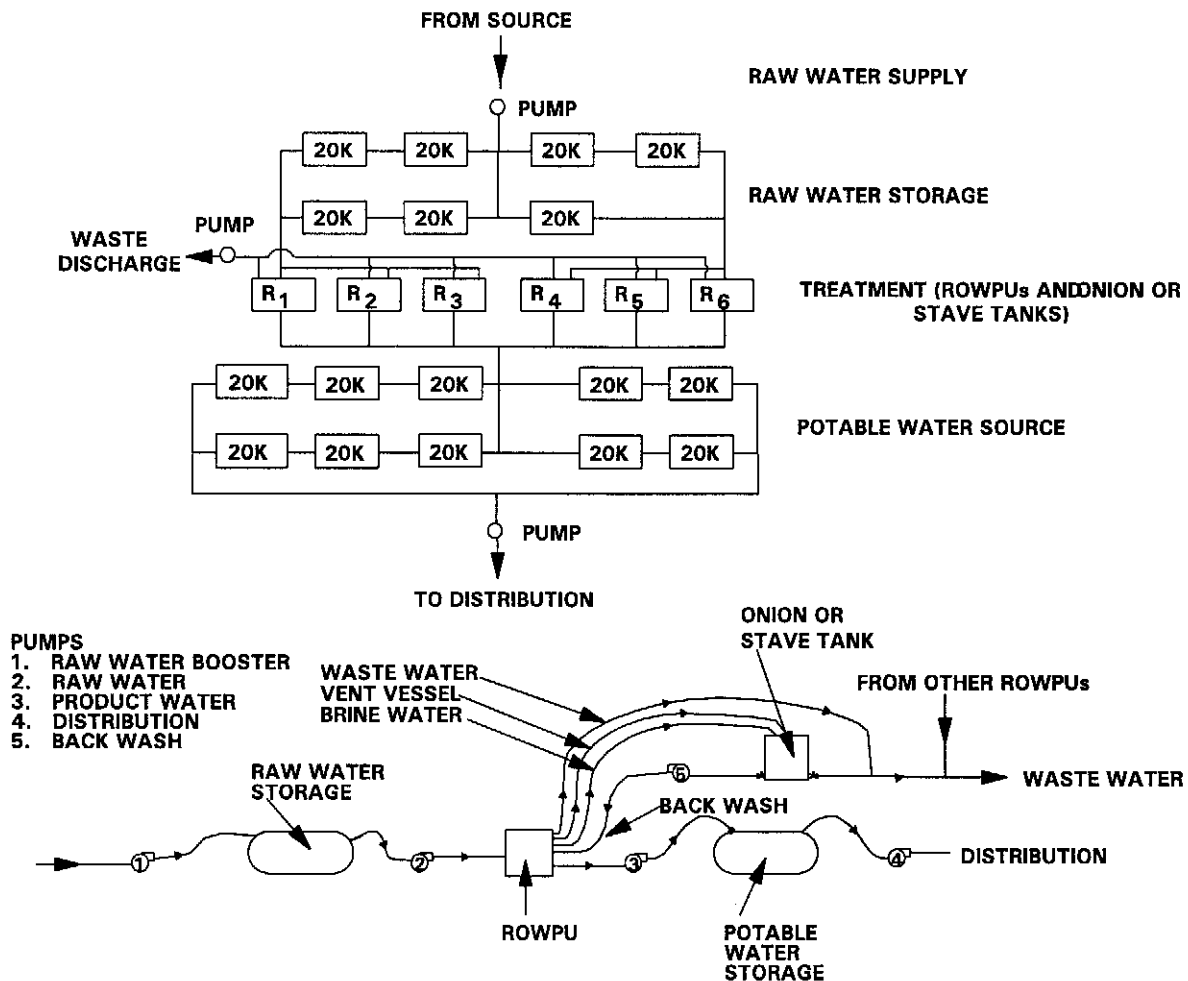


Figure 7.8. Typical Water Treatment Plants (Dispersed).

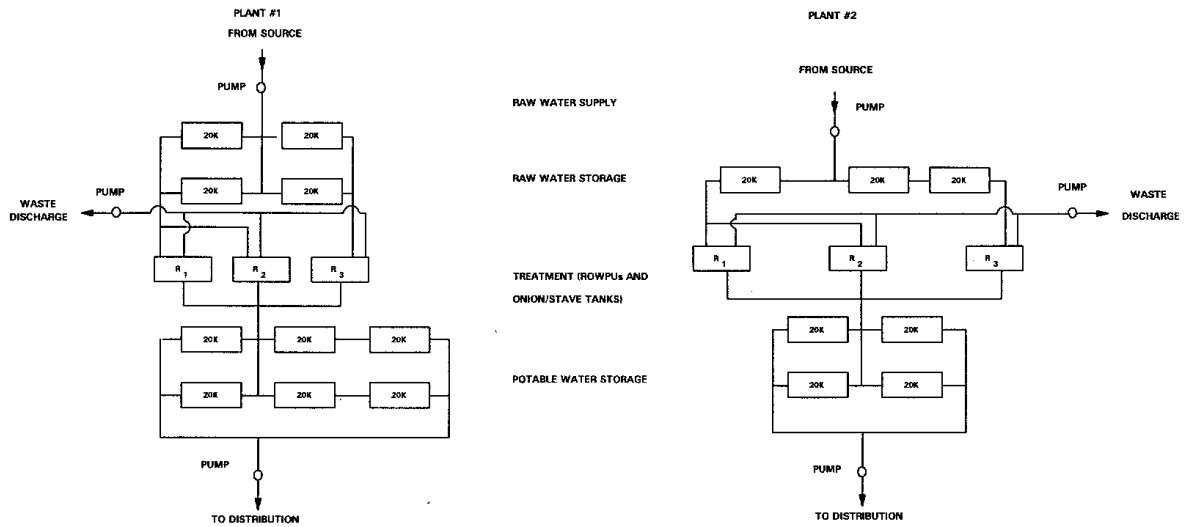


Figure 7.9. Typical ROWPU to Bladder Connection.

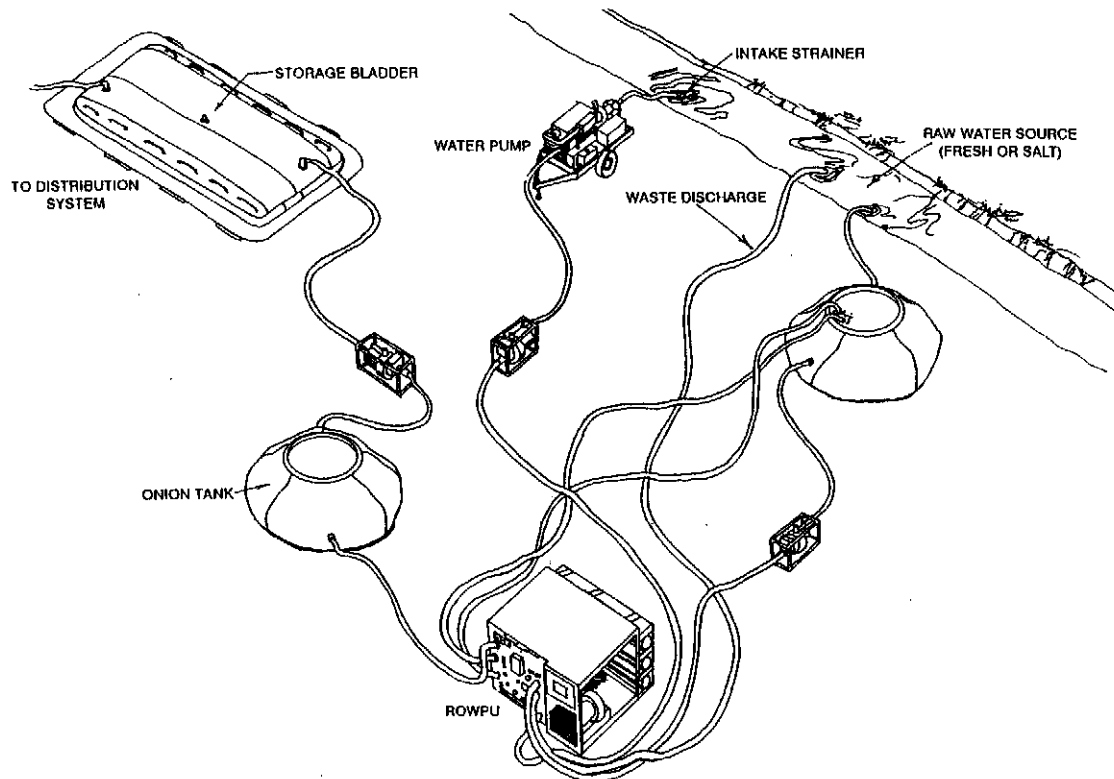


Figure 7.10. Harvest Eagle Water Distribution System.

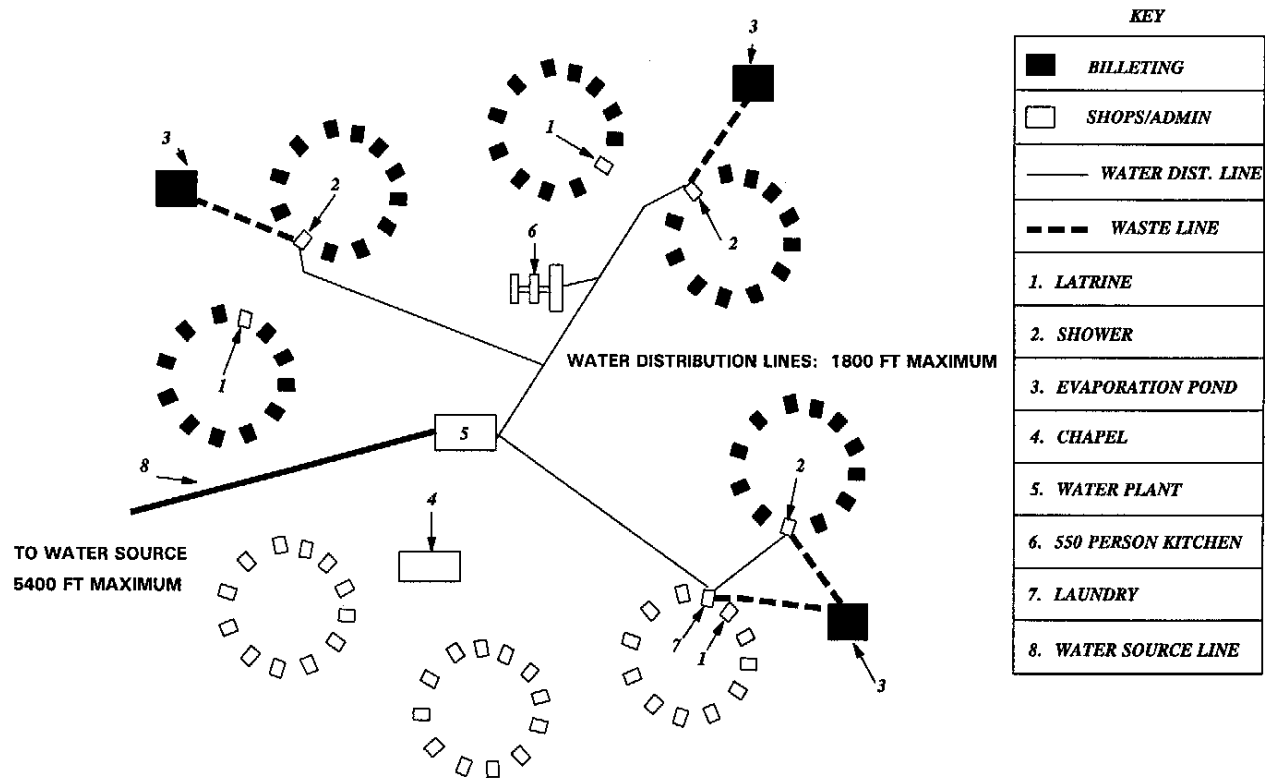


Figure 7.11. 400-Gallon Water Trailers.



Figure 7.12. 3,000-Gallon Onion Tank.



7.7.1.3. Water Distribution. Diesel driven pumping units (figure 7.13) with suction and delivery hoses are provided for the removal of water from a lake, river, or stream. The water can be pumped into a hose distribution line (figure 7.14) or pumped directly into 400-gallon water trailers for transport to a point of use. The distance between the source of water and the encampment determines whether the water is pumped directly from the source to the ROWPU and on to storage bladders, or whether the treated water must be transported and stored somewhere near the point of use. While a distance of one mile is not firm, it is used as a generic guideline for planning purposes. Distances greater than one mile are not practical since elevations from one area to another may vary considerably at deployment locations and, more importantly, there is only approximately a mile of hose available for raw water distribution. Water jugs are provided for individuals who will be working away from the camp. Enough jugs are provided so that one-half the population (275 personnel) can drink one-half a gallon of water a day from the jugs. Lyster bags and water trailers are provided for drinking water storage within the camp.

Figure 7.13. Raw Water Pump.

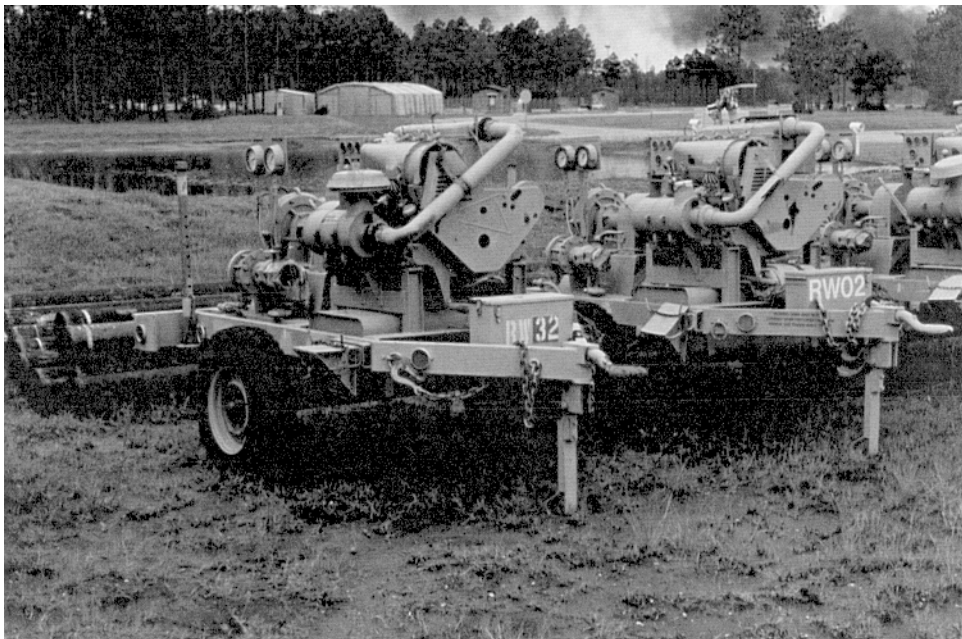


Figure 7.14. Typical Harvest Eagle Water Distribution Hose.



7.7.1.4. **Freeze Protection.** For low temperature operation, the ROWPU and stove tanks must be arranged so that the set is placed in one general purpose (GP) or TEMPER tent, and the 3,000-gallon onion tanks in separate tents. Where practical, two 3,000-gallon tanks can be enclosed within one tent. However, tanks must be located in the center portion of the GP tent to clear the poles. An M-80 water heater is used to circulate water through the tanks. For extremely cold locations it may be necessary to install space heaters in each tent to maintain above freezing temperatures. All hoses not being used to distribute water should be disconnected, drained, and rolled up. In extremely cold weather, water will be distributed by the 400-gallon water trailers.

7.7.1.5. **Wastewater Removal.** Waste (gray) water disposal is handled by electrically driven pumps which are provided in each shower, kitchen, and laundry location. Wastewater lines of light weight flat hose are used to carry the water away from the inhabited area to natural drainage or to a waste disposal system.

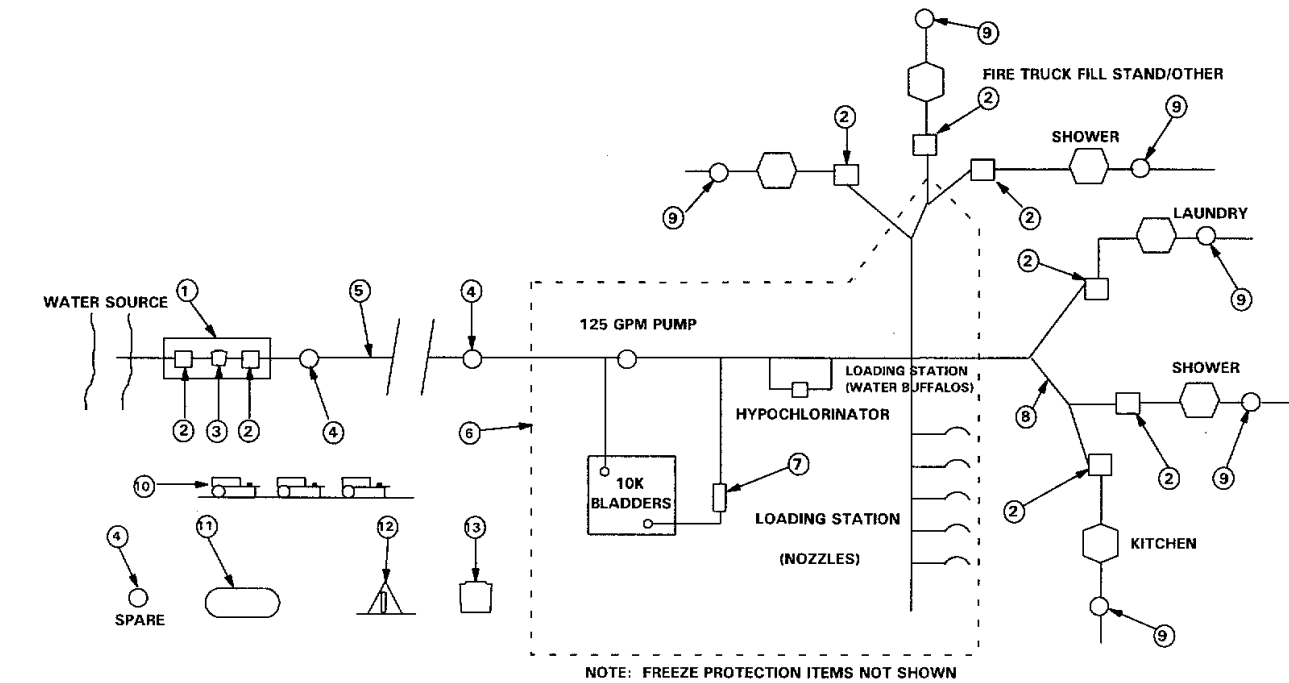
7.7.1.6. **System Layout.** A diagram of a 550-person Harvest Eagle distribution system is shown in figure 7.15. A complete listing of equipment items is in attachment 10.

7.7.2. **Harvest Falcon Water System.** Earmarked primarily for SWA contingencies, the Harvest Falcon water system was specifically developed to support bare base locations. The Harvest Falcon water system is similar in capability to the Harvest Eagle system but provides a more substantial, durable network meant for more extended deployments. While both systems share a considerable number of the same equipment items, there is one major difference in configuration. The Harvest Falcon system uses both hard wall and flexible pipe, normally in a looped fashion, for water distribution through most of an installation.

7.7.2.1. **Operation.** Water is pumped from a raw water source by a 45-hp diesel engine driven raw water pump to raw water storage bladders. The raw water is then pumped from the bladders to ROWPUs for treatment. After treatment, the now potable water is pumped to potable water storage bladders. Up to this point, all water is unpressurized. To place the distribution system under pressure, water is pumped from the potable water storage bladders by booster water pumps. These pumps provide pressurized water up to about 70 psi to all user distribution points through a conventional plastic (PVC) piping system. The system is looped as much as possible to keep water moving and to enhance survivability. When two water treatment plants are used, they are also looped together. See attachment 11 for water system schematics.

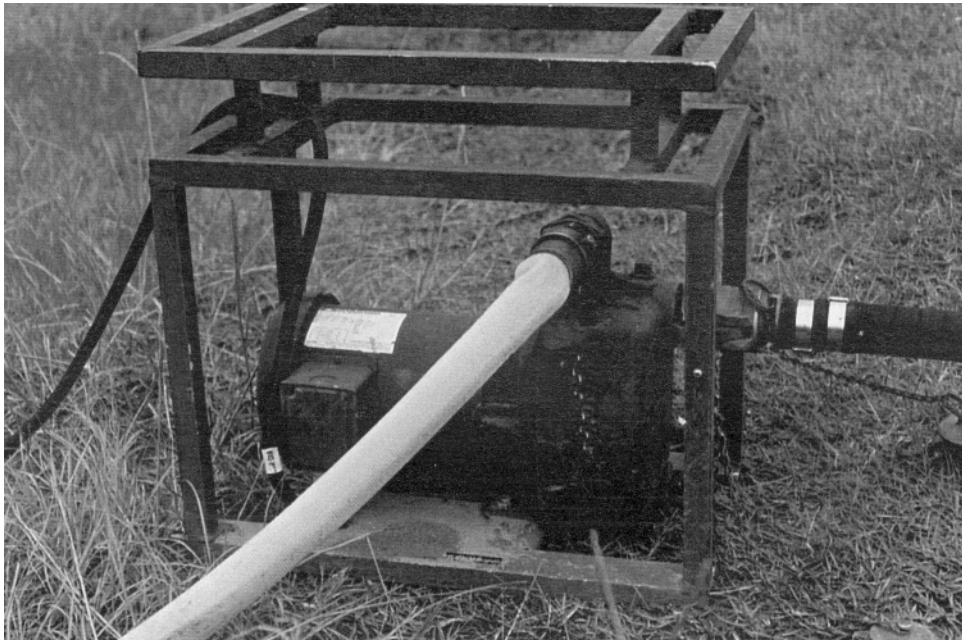
7.7.2.2. **Pumps.** A 45-hp diesel-driven pump with a variable capacity is used to pump water from remote sources to various water treatment stations and to raw water storage bladders. The pump is rated at 250 gal/min at 260-ft head. The pump unit is mounted on a 2-wheel trailer for mobility (figure 7.13). A diesel-driven fire transfer pump is used to pump water from a source water supply point or from raw or potable water bladders to fill fire vehicles. This pump is rated at 500 gal/min at 10-ft head. There are two types of potable electric water booster pumps (figure 7.16) used to pressurize the potable water distribution system. One pump is rated at 40 gal/min at 58-ft head and the other is 130 gal/min at 160-ft head.

Figure 7.15. Harvest Eagle Water Distribution System Layout.



COMPONENT DESCRIPTION	
1. TEMPER Tent	8. Connection kit
2. 3000 gallon onion tank	9. Waste disposal unit
3. 600 gph ROWPU	10. 400 gal. water buffalo with chiller
4. 125 gpm pump	11. Semi-trailer mounted fabric tank, 4750 gal.
5. 4" dia. collapsible hose	12. Lyster bag
6. Storage/distribution system	13. 5 gallon jug
7. Back-pressure regulator	

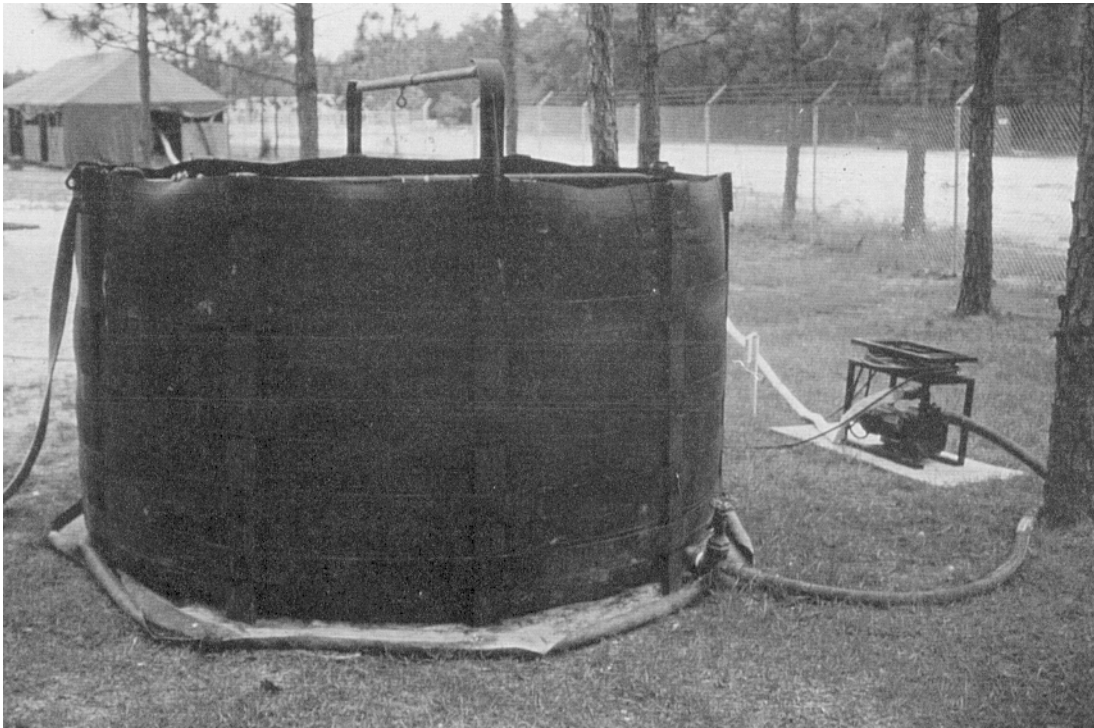
Figure 7.16. Typical Harvest Falcon Electric Booster Pump.



7.7.2.3. Piping. Most Harvest Falcon water distribution pipe is constructed of lightweight, hard wall plastic material with diameters up to six inches. The pipe comes with color coded bands to differentiate between raw water (green), potable water (white), and wastewater (yellow) pipelines. These PVC pipes have a high impact strength over a wide temperature range and are able to maintain an adequate pressure rating at temperatures up to 125 degrees Fahrenheit. They are connected together by quick disconnect couplings and reducers are used to go from one size pipe to another. At first these pipes are placed above ground to save time, but should be buried when time permits. In areas of extreme heat all water lines should be buried approximately 18 inches whenever possible. This will provide insulation, prevent uncontrollable or excessive expansion of the water lines, eliminate solar heat gain, and provide mechanical protection to the system. Deeper coverage is not warranted unless the line will be crossed by heavy traffic, and then it may be better to place the line in a concrete or makeshift culvert for protection from heavy equipment. Buried pipelines should be well marked, particularly in sandy areas, to make inspection and repair easier.

7.7.2.4. Water Storage. Water is stored using a combination of 20,000-gallon bladders, 1,500-gallon water distribution trucks, 400-gallon distribution trailers, 3,000-gallon onion or stave tanks, 36-gallon lyster bags, and 5- and 10-gallon igloo water coolers. The collapsible water bladders are used for storing both raw water received from the source (approximately 40 percent of the total requirement) and potable water processed by the water purification units (approximately 60 percent of the total requirement). The 3,000-gallon onion or standard stave tanks (figure 7.17) are used for storage of brine water from the ROWPUs; the distribution truck, distribution trailer and igloo coolers are used to haul to locations where water is required. The lyster bags are a source of water for drinking or personal hygiene in the billeting and work areas. It must be noted that considerable water is stored within the pipelines themselves. For example, a 6-inch pipeline, two miles long from the water source to the water treatment area, requires approximately 16,000 gallons just to fill it. Shade must be provided in areas of extreme heat, since water storage containers (pipelines, tanks, drums, bladders, water trailers, lyster bags) in direct sunlight can reach temperatures of 200 degrees Fahrenheit. Uncirculated water cannot be expected to cool much at night because water retains heat for a considerable time. Field expedients can be used to provide shade; suspended camouflage nets, tarpaulins, tent sections, and survivor blankets are quite effective. Painting storage vessels a light color that reflects, rather than absorbs the heat, will also keep water at a lower temperature. To aid in the planning for expedient shading, a 20,000-gallon storage bladder has dimensions of 29 feet long by 24 feet wide by 5-2/3 feet high.

Figure 7.17. Typical Stave Tank.



7.7.2.5. System Employment. Because the Harvest Falcon water system requires considerable time and effort to completely set up and is incrementally shipped in the housekeeping and industrial sets, certain tactics must be used during its installation. The water system portion of the housekeeping set includes two increments: unit type codes (UTC) XFBW7 and XFB12. The first UTC contains three ROWPUs and the second UTC includes pumps and flexible hose. When this equipment arrives, the initial step should be to establish and develop the water source. Once the capability to obtain water is reached, water production, i.e., treatment, should be started. The flexible hose sections included in the Harvest Falcon package should be laid out to supply primary users and water points. This action provides an initial operating capability for the base. The industrial set also includes two increments of the water system: UTCs XFB11 and XFB13. These UTCs include additional pumps and hardwall piping; however, it is likely that these items will not be airlifted until late in the industrial set movement flow. When these assets do arrive, efforts can be made to install the more permanent PVC piping in an above-ground mode. PVC installation should continue until all users have been connected to the system. The flexible hose used initially for distribution purposes can be removed as the PVC piping picks up the water distribution requirements. Once all users have been supplied, system components operationally checked, and any other major utilities related beddown tasks completed, actions should be focused on burying the PVC system if the anticipated deployment duration warrants it.

7.8. Water Cooling. The temperature of water for some locations in SWA is known to be supplied at over 120 degrees Fahrenheit. While the effects of such temperature on equipment and human consumption has not been accurately determined, it is believed that this water temperature must be brought within the range of 60 degrees to 70 degrees Fahrenheit in order to encourage personal consumption and to avoid dehydration. Also, some cooling may be required prior to usage for showers.

7.8.1. Cooling of Drinking Water. Several methods of providing cooled drinking water are available. Where water is already on-hand, water coolers are used if available. A centralized distribution point for chilled water and ice should be located at one of the water treatment plants to provide for personnel who do not otherwise have access to water. Lyster bags and mobile water chillers are used to provide cooled drinking water to persons in remote areas of the base. The number of water coolers required for a specific base population is relative to the chilled water output of a given unit. Consider, for example, a water cooler which provides 15 gal/h of cooled water at a temperature of 68 degrees Fahrenheit when the ambient air temperature is 120 degrees Fahrenheit and the supply water temperature is 110 degrees Fahrenheit. This cooler would theoretically cool 360 gallons of water per day. But to do this, the unit would have to operate continuously and would not consider a backlog of people who require a drink simultaneously during periods of peak shelter occupancy, or following mass physical exercise or work. Therefore, the unit should be derated at least 30 percent or to an output of 252 gallons per day. Since each person should consume up to four gallons per day, one water cooler will service approximately 63 people. Water coolers should be of the type with a downward water flow, allowing water to be drawn to fill canteens and drinking containers without excessive waste. If these water fountains are not provided as part of the Harvest Falcon package, serious consideration should be given to local purchase of suitable units.

7.8.1.1. It may be necessary to provide other methods to cool drinking water which will be consumed in remote work areas. Potable chilled water points with provisions for making ice should be established at a selected water treatment plant (see para.

7.8.2.). On-base personnel would have immediate access to chilled water, while those in remote areas would have access while visiting the base. When desired, chilled water and ice can be taken in insulated water containers to work sites or remote areas for later consumption.

7.8.1.2. Lyster bags can be used to provide cooled drinking water at remote areas and should be placed in billeting and work areas not being served by water fountains. Lyster bags will probably be the source of last resort for drinking water; however, they are an excellent source of water for personal hygiene and comfort cooling. As a rule of thumb, allocate one lyster bag per 37 personnel. Despite evaporation loss, this will provide nearly one gallon of water per individual when lyster bags are properly dispersed throughout the deployment site.

7.8.1.3. The mobile water chiller (figure 7.18) is also used to provide cooled drinking water at remote sites. The mobile water chiller mounts on the M-149 series water trailer. It is capable of cooling 120 degree Fahrenheit water to 60 degrees Fahrenheit at a rate of 800 gallons per day. Assuming that half of the work force will require half of their daily drinking water cooled in this fashion, a requirement will exist to cool 1-gallon per person per day utilizing mobile water chillers mounted on the M-149 water trailer. Two M-149 water trailers and chillers are adequate for each 1,100-person increment. For deployments greater than 2,200 personnel, two spare trailer and chiller units should be included.

Figure 7.18. Mobile Water Chiller.



7.8.2. Ice Plant. To supplement chilled water requirements, approximately 4.4 pounds of ice per person per day should be provided. Ideally, an ice plant should be established at one of the water treatment plants to support the base populace. Currently, however, ice making machines capable of meeting overall base-wide ice requirements are not part of the bare base asset inventory, although efforts are underway to identify such equipment. Limited ice making capability is available at the dining halls but this is primarily for food service support. Table 7.2 depicts basic ice requirements for initial bare base populations.

Table 7.2. Ice Machine Requirements.	
BASE POPULATION	ICE REQUIREMENTS (pounds/day)
1,100	4,840
2,200	9,680

3,300	14,520
-------	--------

7.9. Water Conservation. Americans do not use water sparingly. Consequently, part of our training before deploying to arid regions must include intensive instruction on water conservation. Such training should be accompanied by measures to make water less available. This will reduce the temptation to return to wasteful habits.

7.9.1. Planners Advice. Conservation must begin with you; you must be aware of the need to save water and must be taught about the many opportunities to reuse wastewater for some other purpose. You must be assisted in this effort by everyone up the chain of command. There is no substitute for command emphasis on water conservation.

7.9.1.1. As planners, you will play a major role in the conservation effort. For example, activities which require large amounts of potable water should be located near water terminals and tank farms to minimize transportation requirements and losses during handling. In addition, facilities that may use nonpotable water should be sited near a suitable generator of wastewater -- for example, wastewater from laundry and shower units could be used for concrete mixing, soil compaction, and dust control needed for the installation of storage depots.

7.9.1.2. Planners should also consider using seawater or brackish water. Both sources can be used for concrete, soil cement, soil compaction, and dust control. The two latter tasks are likely to constitute major civil engineer efforts. The existing road network at many bare base sites is limited and will require expansion; and, the rapid deterioration of existing and newly established roads from heavy traffic will demand continuous maintenance. Also, nonpotable water can be used for the decontamination of certain items of NBC-contaminated equipment, should the need arise.

7.9.1.3. Much can be learned from some of the water-conserving habits of the region's inhabitants. The basic water conservation principles listed below should be observed by everyone operating in a water-scarce arid environment. Desert dwellers, particularly the nomadic tribes, have relied on similar water discipline for centuries.

7.9.1.3.1. Make it a responsibility shared by everyone to conserve water by avoiding wasteful practices and being always conscious that there is some useful purpose for wastewater or potable water which is hot and therefore unpalatable.

7.9.1.3.2. Place command emphasis on water conservation and water reuse.

7.9.1.3.3. Protect potable water from all sources of contamination, including sand and dust.

7.9.1.3.4. Do not dispose of water of any type without considering alternative uses.

7.9.1.3.5. Prohibit water thievery from storage containers and pipelines, and the indiscriminate use of expedient showers.

7.9.1.4. The use of water of lesser quality is also a viable method of conservation. In SWA, where the dissolved solids content of water can be quite high, any opportunity to use local water and avoid the costly reverse osmosis treatment process has both logistic and economic advantages. These benefits are most apparent when it comes to water required for bare base construction tasks. Untreated seawater or brackish water is quite satisfactory for construction that is only intended to see short-term use.

Chapter 8

WASTE UTILITY SYSTEMS



8.1. Introduction. Since water was claimed to be "the only thing" essential to bare base operations, the disposal of wastewater and other wastes may seem to be of lesser importance. Quite the opposite is true; unless wastes of all types are quickly and properly disposed of, unsanitary conditions will quickly develop. Flies, mosquitoes, and rodents will soon overwhelm the bare base, spreading disease with them. During previous conflicts, the casualty rate from disease and other nonbattle causes has invariably exceeded the combat casualty rate. This is particularly true for theaters of operation where high temperatures, the prevalence of disease, and poor living conditions combine to endanger the health of the troops. In such areas non-battle casualties commonly outnumbered battle casualties by a four-to-one ratio.

8.1.1. Field Sanitation. Despite many medical and technological advances, the threat from insect-borne diseases and sanitation hazards remains as real today as it was in World War II, Korea and Vietnam. Computer simulations conducted by Air Force medical entomologists predict that about 95 percent of the troops deployed to areas with poor sanitary conditions and high rates of insect-borne diseases would contract malaria within 240 days. With proper application of field sanitation and insect control methods the prediction shows that the malaria rate would not exceed five percent - a much more acceptable level. Americans are accustomed to the amenities of a sanitary environment and find it difficult to cope with the austere, primitive conditions they encounter in the field. When confronted by a lack of stateside, permanent base-type facilities during exercises and contingencies, some individuals showed a tendency to relax customary sanitation and personnel hygiene standards. This poses a threat to the entire command and, if such conditions were to be tolerated in a future contingency deployment, mission accomplishment could be seriously affected. This presents a real challenge to bare base planners who may have to rely on expedient methods for waste disposal during the early stages of Harvest Eagle and Harvest Falcon deployments.

8.1.2. Environmental Considerations. In addition to the more familiar, traditional waste disposal problems, engineer forces must now also consider those types of wastes which pose potential environmental problems if not monitored. Items such as fuels, chemicals, and process by-products must be controlled and properly disposed of so as not to create future health and safety hazards. If safe disposal is not an immediate option at a bare base location, as a minimum an adequate, secure storage area should be established. Be especially observant of any local national activities that might be under Air Force control. Local environmental rules and regulations at a bare base location may not be as strict as U.S. standards, therefore may pose an eventual environmental problem for U.S. forces if not watched closely.

8.2. Overview. To assist you in this planning, this chapter describes the various methods for disposing of wastes. Expedient field methods for waste disposal are addressed first, followed by a discussion of Harvest Eagle and Falcon methods for disposal of liquid wastes applicable to longer-term deployments. Finally, this chapter presents the methods available for the disposal of solid wastes.

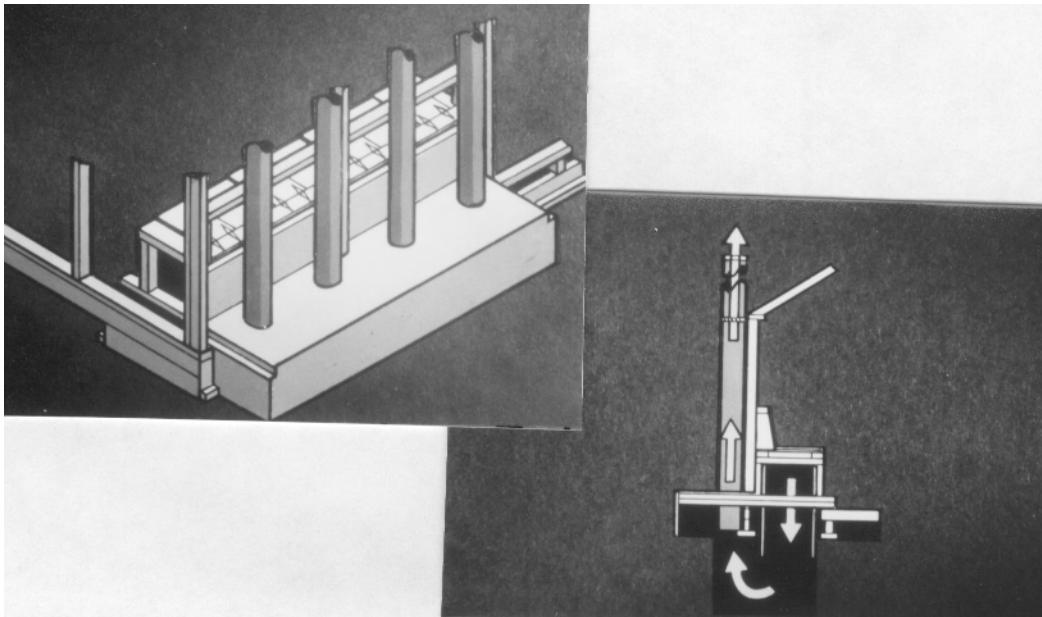
8.3. Expedient Field Methods. During the early stages of most deployments, even those using Harvest Eagle and Harvest Falcon assets, expedient field methods will have to be used to dispose of wastes. Additionally, even when Falcon and Eagle

assets are employed, there may be locations on the base which must be served with expedient facilities due to distances from main utility networks or lack of mobile assets. Finally, in those instances where no mobility assets are available, field expedient methods will be the only option. Six types of expedient latrines have proven effective for the disposal of human waste. For planning purposes, assume that one toilet will serve 17.5 personnel. Where the latrine will not be used by women, urinals may be substituted for one third of the minimum required number of toilets. Separate latrines must be provided for women. Since about 16 percent of Air Force personnel are women, you should plan on providing a corresponding percentage of bare base latrine facilities for the female population.

8.3.1. Ventilated Improved Pit (VIP) Latrine. VIP latrines are the best method for disposal of human wastes in the absence of a sewage system. When properly designed and constructed, they are sanitary and devoid of odor and insects.

8.3.1.1. There are various designs of VIP latrines (figure 8.1), but they all differ from traditional pit latrines in having a vertical vent pipe which has a fly screen at its top and which leads directly from the pit beneath. The vent pipe generates a strong updraft and maintains a flow of air down through the latrine pedestal. The effect of this airflow is to minimize odors in the superstructure and to discourage breeding of insects (flies and mosquitoes) in the pit. Most flies approaching a latrine will be attracted to the top of the vent pipe by the fecal odors being discharged there, but the fly screen prevents them from entering the pit. Moreover, provided the superstructure is kept reasonably dark, any flies that hatch in the pit are attracted to the daylight at the top of the vent pipe but are prevented from leaving by the fly screen; they eventually fall back into the pit and die.

Figure 8.1. Ventilated Improved Pit Latrine.



8.3.1.2. The latrine should be oriented so that the maximum amount of direct sunlight reaches the black vent pipes. On calm days, proper ventilation of the pits relies on the air inside the vent pipes heating up, rising and sucking the foul air upwards. Facing vent pipes southward aids this process. When this is impossible, try facing vent pipes east or west; avoid north.

8.3.1.3. Urine and small amounts of water entering the pit will eventually evaporate or soak into the soil. However, excessive amounts of water from bathing or cooking must not be emptied into the pits. This water would accumulate and harbor breeding insects.

8.3.1.4. When not in use, the pedestal seat cover should be kept closed. This will discourage insects from entering the pit and will keep the pit dark. Thus, insects will be forced to travel up the vent pipes towards light and will be trapped by the fly screen. Air will continue to enter the pit through the gap under the seat, maintaining the ventilation of the pit.

8.3.1.5. The fly screens at the top of the vent pipes and the cover slabs over the pit should be inspected periodically to ensure that they are properly secured and in good condition. Fly screens should be made of plastic-coated glass fiber mesh only.

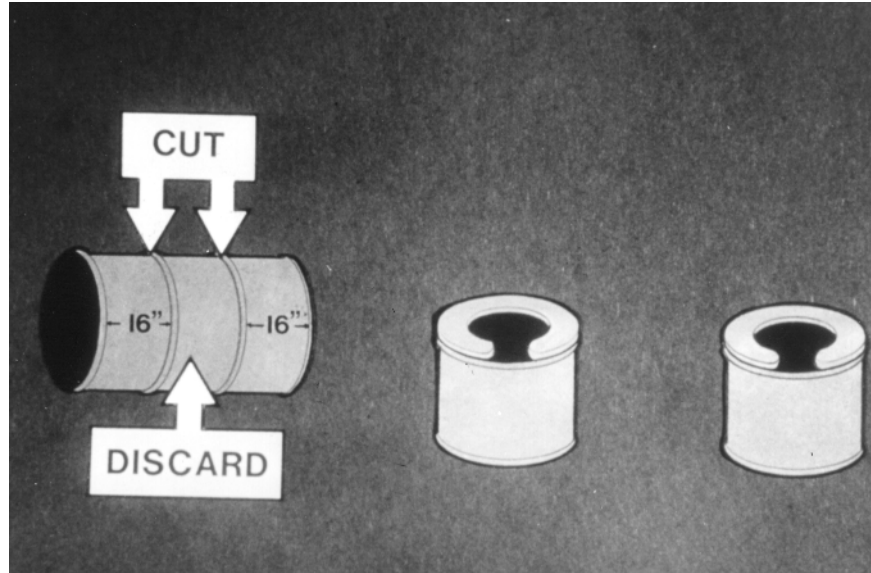
8.3.1.6. Proper design of the vent pipe is essential for the correct functioning of VIP latrines. Underdesign will normally cause problems in odor and insect control, and overdesign will increase cost unnecessarily. Housed in a general purpose medium tent or TEMPER tent, this latrine will support approximately 270 personnel. It has 12 latrine seats and two trough urinals.

8.3.2. Burnout Latrine. One of the simplest and most effective latrines to construct is the burnout latrine. Its ease of construction, portability, and maintenance make it one of the best latrines to use in field conditions (figure 8.2).

8.3.2.1. To construct a burnout latrine, cut a 55-gallon drum in two parts, approximately 16 inches from both ends (discard the center section of the barrel). Place a preconstructed toilet seat over each end section of the drum. The dimensions of the seat are determined by the diameter of the drum. The toilet hole should be a 9-inch by 12-inch ellipse.

8.3.2.2. The following guideline figures can be used to estimate the various economic or use factors involved:

Figure 8.2. Burnout Latrine.



8.3.2.2.1. Average usage factor - 14 people/can.

8.3.2.2.2. Average fuel consumption - 2 gallons/can/day and 0.15 gallons/person/day.

8.3.2.2.3. Average usable life of each can - 90 days.

8.3.3. Pail Latrine. A pail latrine may be built when conditions (populated areas, rocky soil, marshes) are such that a dug latrine cannot be used. A standard type latrine box (figure 8.3) may be used as a pail latrine by placing hinged doors on the rear of the box, adding a floor, and placing a pail under each seat. The pails should be cleaned daily; more often, if needed. They may be buried. After cleaning and when replaced, the pails should contain one inch of disinfectant. Chlorox is the most commonly used disinfectant for this purpose.

8.3.4. Bored Hole Latrine. This latrine consists of a hole about 18 inches in diameter and from 6 to 20 feet deep covered by a one-hole latrine box (figure 8.4). A converted metal drum or trash can may be sunk into the ground for use as a box. Both ends of the drum are removed and a fly proof seat cover, with self-closing lid is made to fit the top of the drum. This type of latrine is satisfactory for small deployments or remote work locations, provided the necessary mechanical equipment for boring the hole is available.

Figure 8.3. Pail Latrine Box.

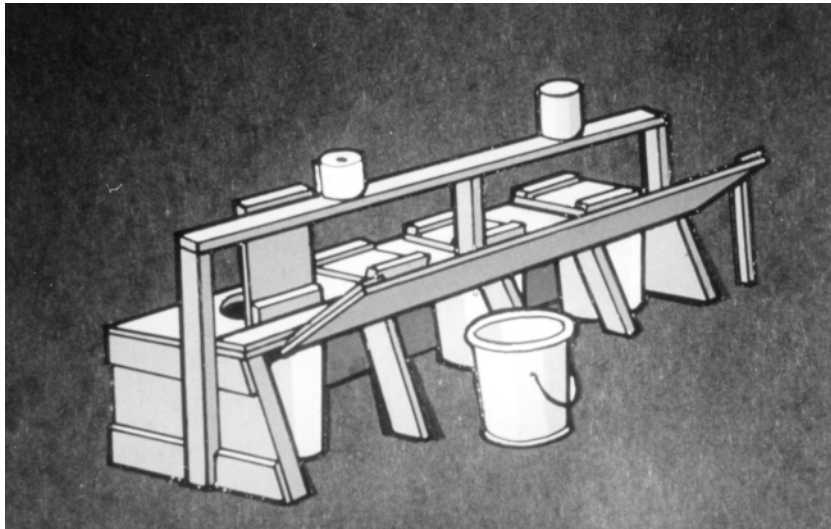
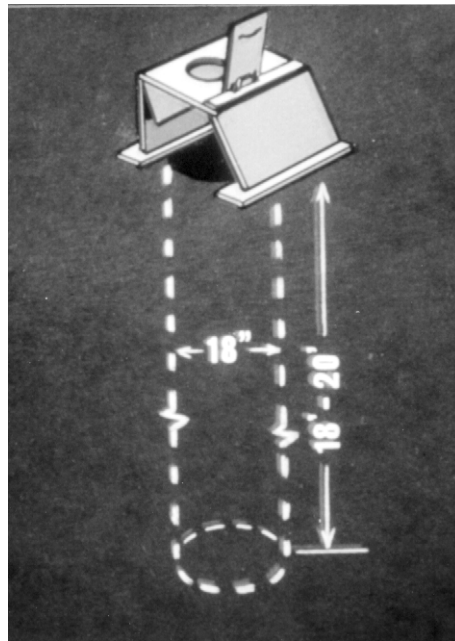


Figure 8.4. Bored Hole Latrine.



8.3.5. **Straddle Trench Latrine.** This latrine consists of trenches dug 1 foot wide, 2-1/2 feet deep, and 4 feet long. The earth removed in digging is piled at the end of the trench and is then used to cover excreta and toilet paper (figure 8.5). When the latrine has been filled to within 1 foot of the surface or when it is to be abandoned, it must be closed. Because of the lack of privacy and its crudeness (by American standards), the straddle trench latrine may not be accepted by the base populace. Also, in sandy soils it may be difficult to establish trenches of sufficient depth; footing along the edges may be unstable and may cause latrine users to lose their balance. For these reasons, consider the straddle trench latrine only as a last resort measure.

8.3.6. **Urine Soakage Pit.** This consists of a hole dug 4-feet by 4-feet by 4-feet and filled with large stones on the bottom, small stones next, and then fine gravel. A trough box should be constructed as shown in figure 8.6. The corner where the drain pipe is located should be slightly lower to allow for drainage.

8.3.7. **Evaporation Beds.** Laundries, showers, and kitchens also generate wastewater which must be disposed of. When soil is very impervious, making the use of soakage pits impossible, evaporation beds must be used.

Figure 8.5. Straddle Trench Latrine.

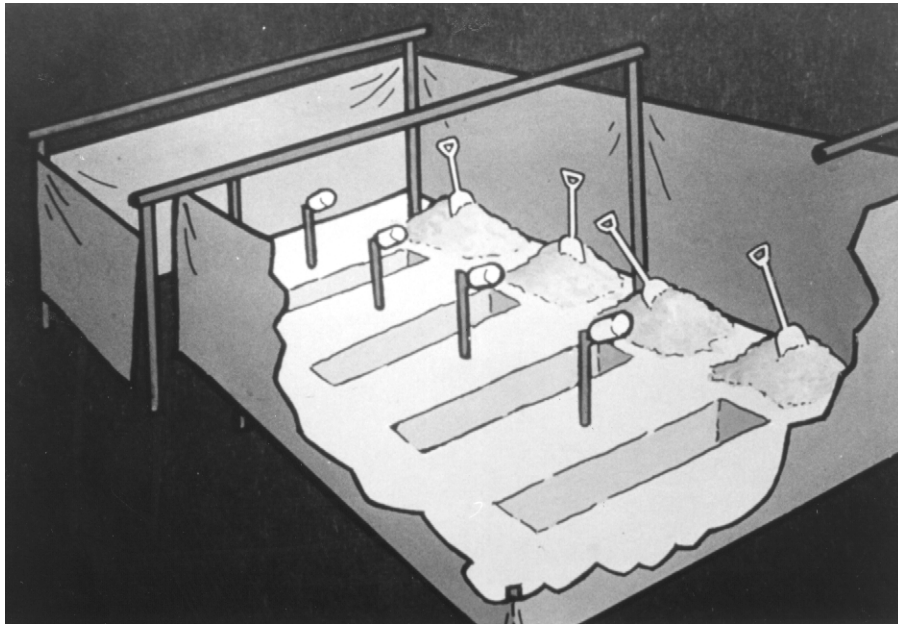
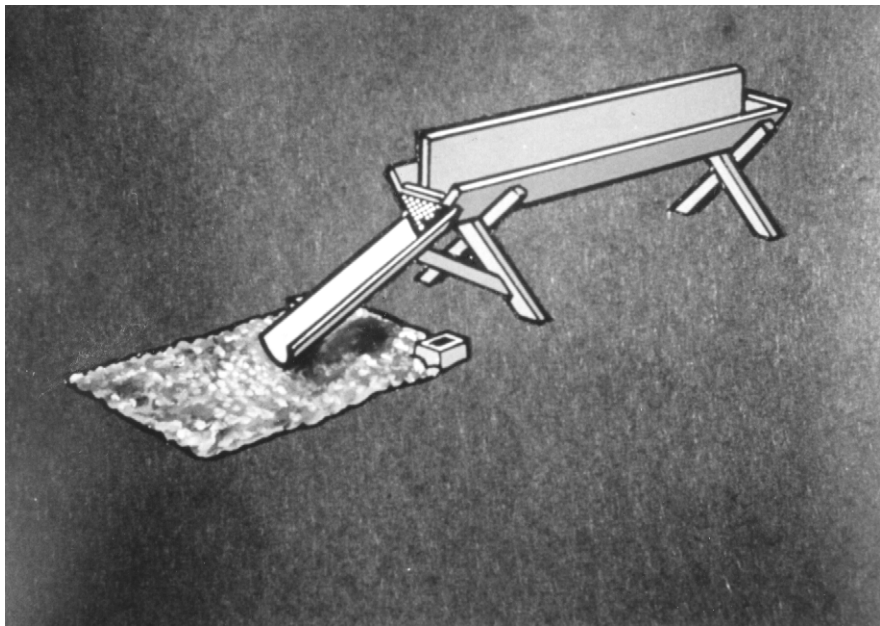


Figure 8.6. Trough Urinal and Soakage Pit.



8.3.7.1. To determine the size of evaporation beds, allow 3 square feet per person for kitchen wastewater and 2 square feet for shower and laundry waste. The total area should be divided by 7 and evaporation beds constructed as seven individual units - one for each day of the week. Beds should be placed so that wastewater can be channeled to any particular bed as desired.

8.3.7.2. As an example, an 1,100-person Harvest Falcon kitchen would require 3,300 square feet of evaporation bed, divided into seven individual beds of 472 square feet. Each bed would measure about 22 feet by 22 feet. The kitchen will produce about 2 gallons per person per day (gpd) of wastewater for a total of 2,200 gallons or 294 cubic feet. Each bed should be about 0.62 foot deep. To allow for free board, each bed should be constructed to be 1 foot deep. See figure 8.7 for a typical layout.

8.3.7.3. A similar process should be used for shower and laundry wastewater. Each shower will produce about 1.3 gpd of wastewater. Each laundry will produce 2 gpd of wastewater. However, a simple water conservation technique can cut the water consumption of the laundry in half. The rinse water from the laundry can be collected in a stove or onion tank and used

as the wash water for the next load (figure 8.8). This technique has no adverse effect on the cleanliness of clothes. Use this technique where water is scarce and when wastewater disposal is difficult to accomplish.

8.3.8. Grease Traps. Grease traps must be constructed to prevent grease from entering the wastewater disposal beds. Grease will slow the evaporation process, clog the soil and prevent water from leaching into the soil, and provide food for insects. Several types of grease traps are sufficient to do a good job of removing the grease from liquid wastes in the field. Some are superior to others in that they are easier to construct and last longer. The important thing about any grease trap is that it should be of sufficient capacity so that the hot, greasy water being added will not heat the cool water already present in the trap. Otherwise the grease will remain uncongealed and pass through the trap. Figure 8.9 depicts the two types of expedient grease traps that are easiest to construct.

8.3.9. Soakage Pits. A soakage pit acts as a reservoir from which water is gradually absorbed by the surrounding soil. Its effectiveness depends on the cleanliness of the water being absorbed, level of the ground water table, permeability of the soil, and dimensions of the soakage surface. In areas of rapid soil drainage, such as limestone or coral, small pits will function for long periods of time. In slow draining silt or desert sands, pits must be much larger. Great care must be taken in slow-drainage areas to clear the wastewater thoroughly before running it into a soakage pit (figure 8.10). Soakage pits are generally not recommended for use in areas where soil percolation rates are very poor - SWA, for example. Nevertheless, individual field studies - even when percolation rates are known to be poor - may identify favorable conditions at selected locations. Soakage pits can then be designed based on actual field conditions.

Figure 8.7. Expedient Kitchen Wastewater Disposal.

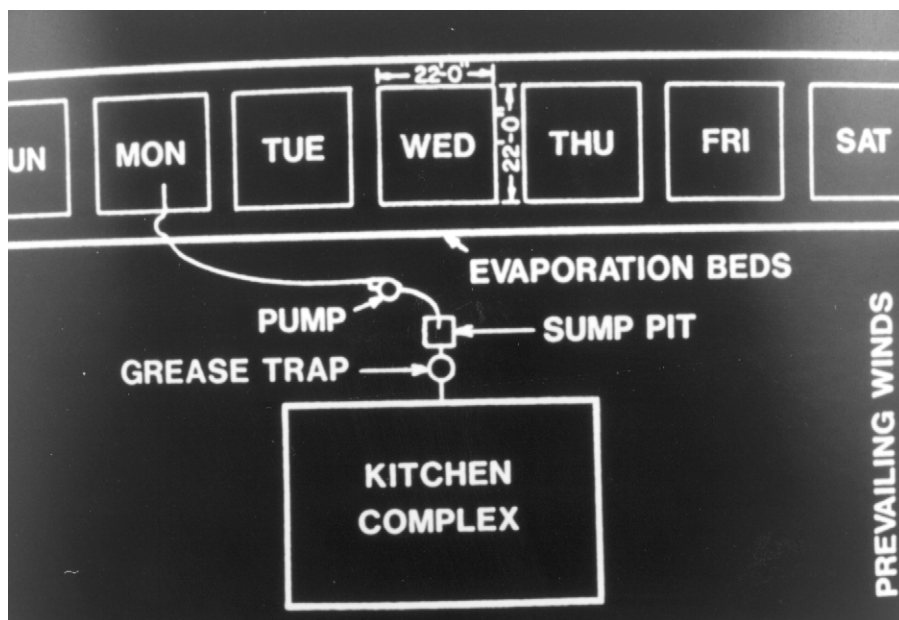


Figure 8.8. Rinse Water Recycling System.

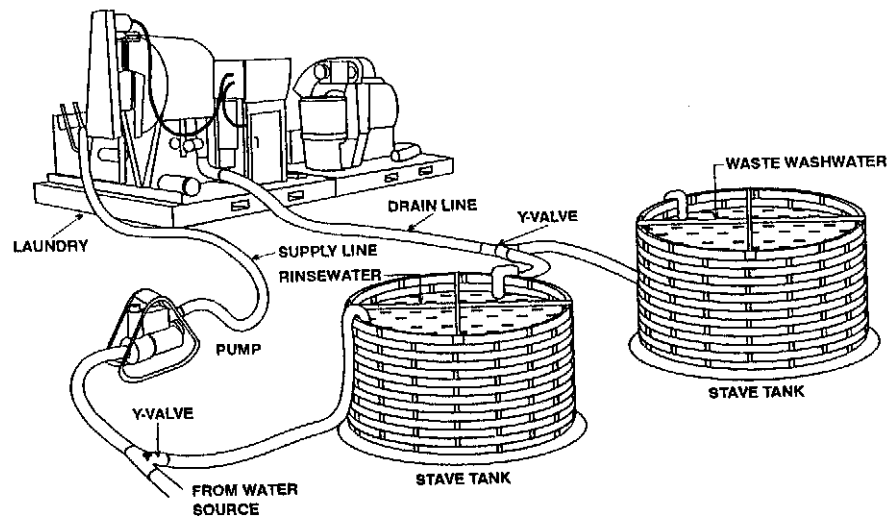


Figure 8.9. Expedient Grease Traps.

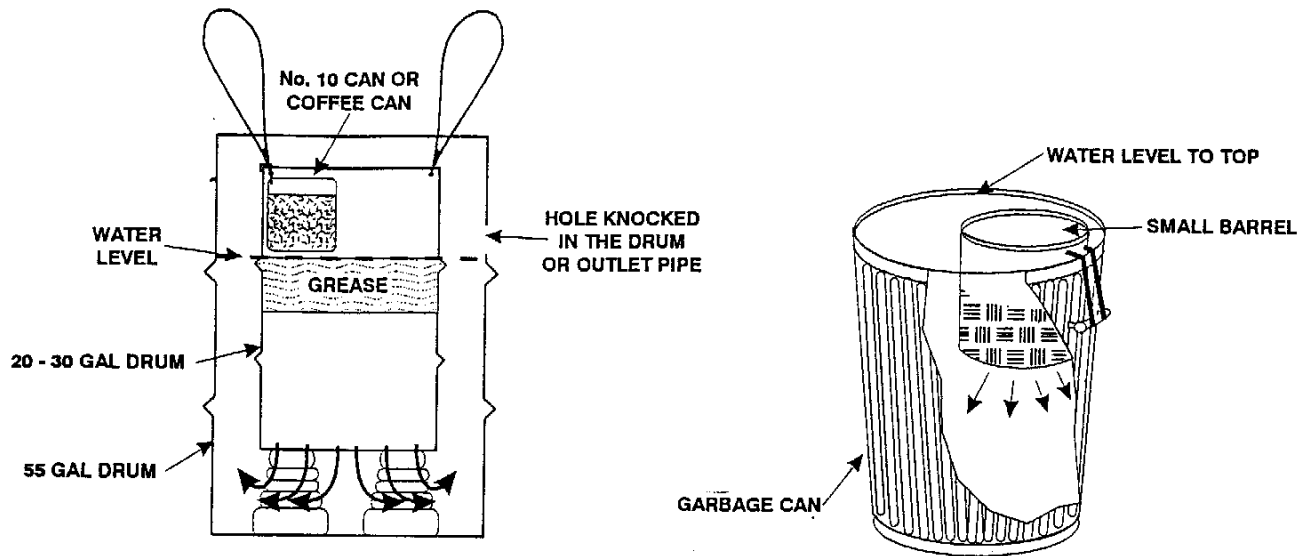
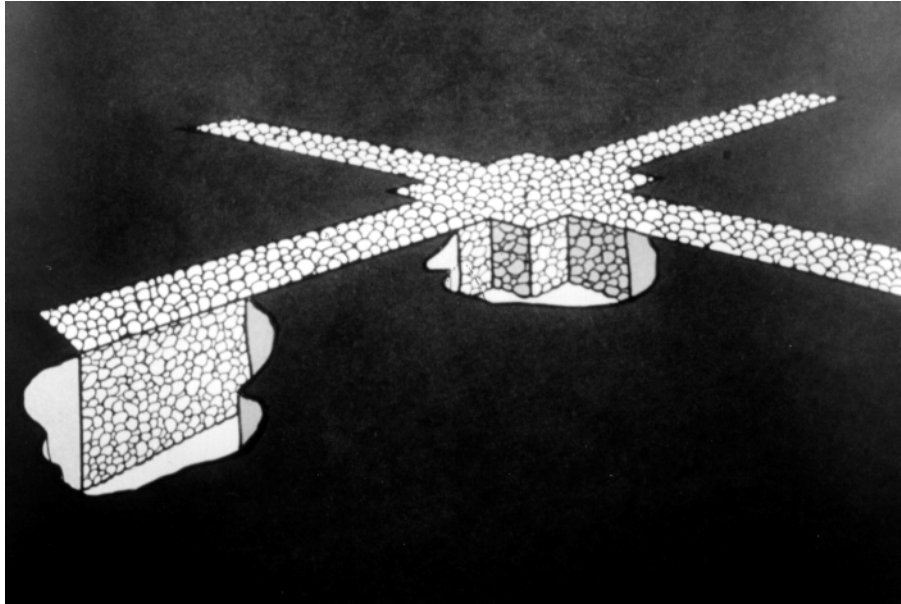


Figure 8.10. Soakage Pit.



8.4. Harvest Falcon Methods. A separate discussion of Harvest Eagle wastewater disposal methods will not be presented since Harvest Eagle relies either on expedient methods or mobile assets identical for the most part to Falcon components. Attention will be paid instead to the Harvest Falcon system which is the more complex of the two mobile facility packages. The wastewater disposal system for Harvest Falcon uses the same concept as a typical municipal wastewater system. Wastewater is collected and transported via a piped system to a centralized treatment area. The wastewater receives the equivalent of secondary treatment and then is discharged off base. Setting up this system takes time. While the system is being constructed, wastewater is picked up at the point of generation by wastewater removal trailers. These trailers are discharged away from the base or into the lagoon system once it is completed. The Harvest Falcon wastewater system is packaged in increments designed to support various populations. Although the type and amount of equipment has been specified, you will have to design a system unique to your deployment location. To help you in designing the system, a discussion of the sources and quantities of wastewater is presented, followed by a description of the collection system. Next, the treatment system is described.

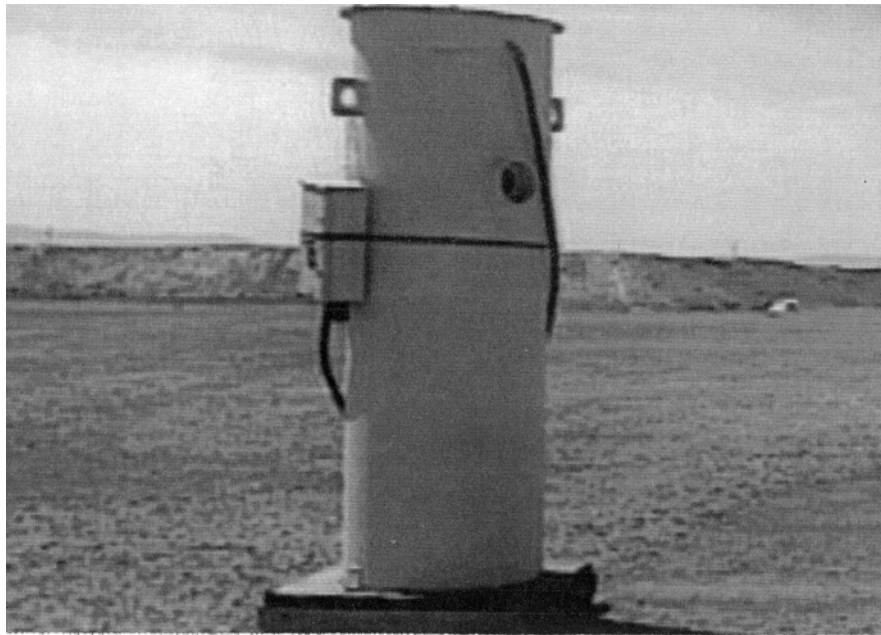
8.4.1. Wastewater Sources. Of the 20 gpd of potable water (see chapter 7 for details on this figure) provided at a bare base, about 14 gpd will be generated as wastewater. Wastewater sources are listed in table 8.1. The information contained in the table will be used to calculate the quantity of wastewater generated in a given area. For example, a typical shower-latrine complex supports 275 personnel. A total of 9 gpd is generated by latrines and showers. Therefore, the latrine complex will generate about 2,475 gallons per day of wastewater. The average hourly flow is 103 gallons per hour. The maximum hourly flow would likely not exceed four times the average hourly flow. Therefore, the maximum hourly flow would be about 410 gallons per hour. This figure should be used for design purposes.

Table 8.1. Wastewater Sources.	
SOURCE	GPD
Latrine	7.7
Showers	1.3
Food Preparation	2.0
Hospital	1.0
Laundry	<u>2.0</u>
TOTAL	14.0

8.4.2. Wastewater Collection System. The bare base wastewater collection system is a combination of Harvest Falcon pipes, couplings and valves; commercial pumps and associated controls; and expedient grease traps. Design of the collection system is largely dependent upon specific site conditions such as slope of the land, soil composition, and predominant wind direction. Typical wastewater collection system schematics are shown in attachment 12.

8.4.2.1. Four inch plastic PVC pipe and quick-disconnected couplings are used for the collection system. The waste collection pipes are identical to those used for the raw and potable water lines but have a yellow color stripe to differentiate their use. Shelter connections should extend 5 feet outside the shelter and drop 1 inch. Beyond this point, pipe may extend up to several hundred feet on a slope of at least one percent (1-foot drop every 100 feet). Lateral lines should be laid on slopes sufficient to provide velocities no less than 2 feet per second and no more than 10 feet per second when flowing full. However, in unfavorable terrain a velocity of 1-1/2 feet per second may be used if excessive depths of trench or use of a pumping station can be avoided. If terrain is encountered where gravity flow is not possible, lift stations (figure 8.11) are provided in the distribution system package to solve this problem. These lift stations are a manhole-type unit made of steel and hard plastic. The inside of the lift stations contain pumps and shredding or chopping devices, which grind waste materials into a slurry. Waste enters the lift stations through inlet connections at the bottom, is pumped through the shredders and then is pumped through outlet connections at the top to lagoons or other lift stations.

Figure 8.11. Harvest Falcon Lift Station.



8.4.2.2. For example, assume a typical billeting area contains five shower-latrines complexes. As described earlier, each complex would produce a maximum flow of 410 gallons per hour. The lateral line serving the billeting area must carry 2,050 gallons per hour or 0.075 cubic feet per second. Use figure 8.12 to determine the slope a 4-inch line must be laid on. First, assume a slope and then see if it is acceptable. For example, assume a slope of 0.01 ft/ft. Referring to figure 8.12, lay a straightedge along the 4 inch mark of the "Diameter of Pipe" scale, and then read a velocity of 2.2 ft/sec and a flow rate (when flowing full) of 0.2 cu ft/sec. Since the flow rate is less than 0.2 cu ft/sec, the pipe will not flow full (which is desirable to avoid pressure in the line); therefore, you must refer to the proportionate flow chart (figure 8.13) to determine the velocity. First, determine the ratio of actual flow to flow when full, or:

$$\frac{Q_{\text{Actual}}}{Q_{\text{Full}}} = \frac{0.075}{0.2} = 0.375$$

Then enter the chart along the proportionate discharge and velocity axis at 0.375 and follow it up until you hit the discharge curve, travel over to the velocity curve and back down to the proportionate axis and read 0.94. This means the velocity is 94 percent of the velocity when flowing full. Therefore, the velocity is:

$$0.94 \times 2.2 = 2.07 \text{ ft/sec}$$

This is an acceptable velocity, so the slope of 0.01 ft/ft is acceptable. If the velocity had not been acceptable, a different slope would be tried. When designing the collection system you should try to minimize the trenching requirements by using as small a slope as possible. This means that design velocities should be around 2 feet per second. Obviously, if natural slope permits higher rates, they should be taken into consideration and used to the best advantage. When trenching depth becomes excessive or to overcome adverse topography, a pumping station is installed. The length of force mains should be kept to a minimum.

8.4.3. Wastewater Treatment and Disposal.

8.4.3.1. In areas where sufficient natural drainage exists to carry wastewater away from the base, stabilization lagoons should be constructed to provide treatment of the wastewater before discharge. Waste organics in a stabilization lagoon are metabolized by bacteria and protozoans. When the lagoon bottom is anaerobic (without oxygen), biological activity results in digestion of the settled solids. Nutrients released by bacteria are used by algae in photosynthesis.

8.4.3.2. The degree of stabilization produced in an oxidation lagoon is significantly influenced by climatic conditions. During warm, sunny weather, decomposition and photosynthetic processes flourish, resulting in rapid and complete stabilization of the waste organics. Biochemical oxygen demand (BOD) reductions in warm weather usually exceed 95 percent. Stabilization lagoons are designed with long liquid retention times, usually 20 to 120 days. Lagoons shown in this chapter have been designed with a retention time of 30 days, suitable for a predominantly hot and sunny region (SWA and equivalent).

Figure 8.12. Pipe Flow Graph.

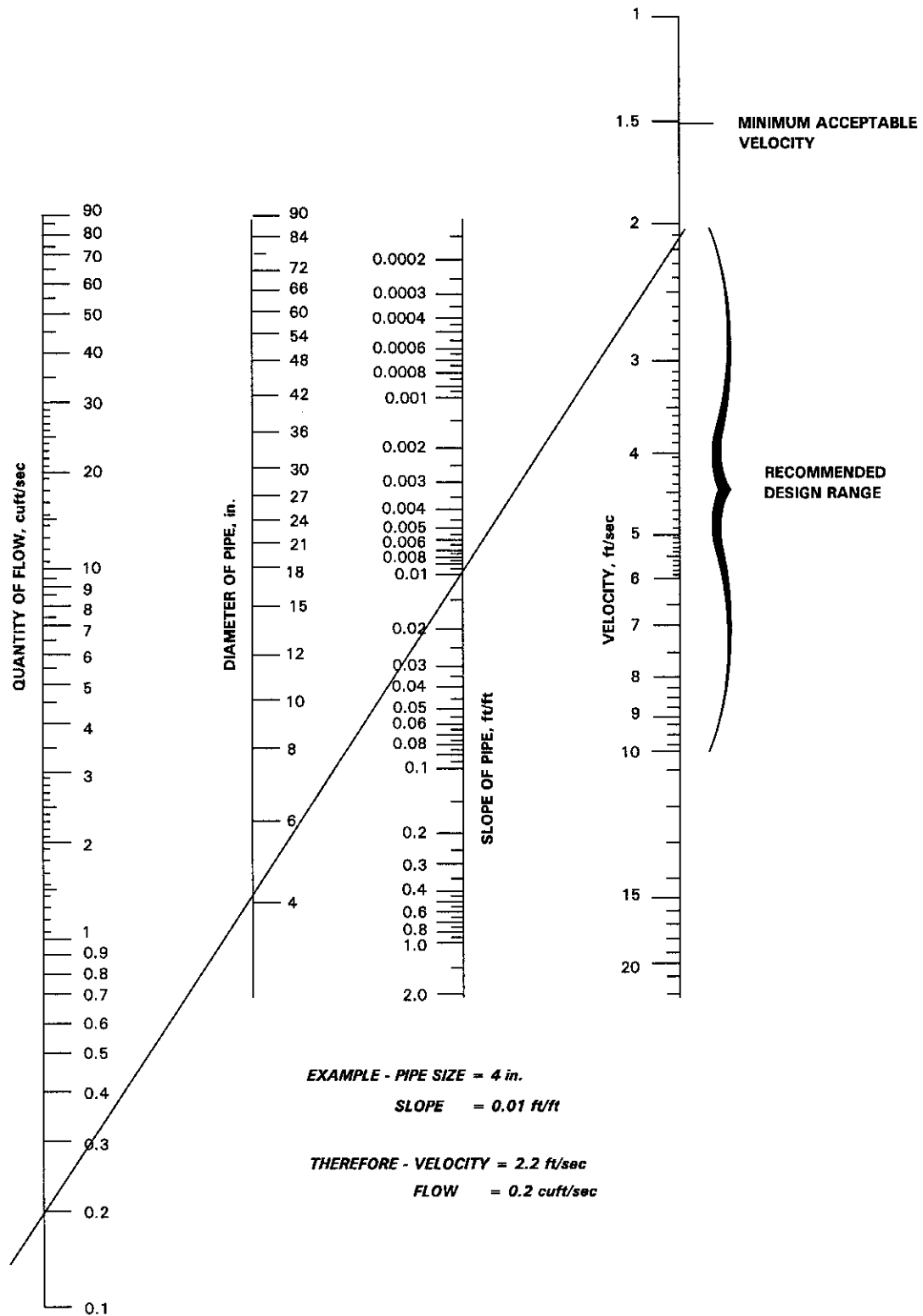
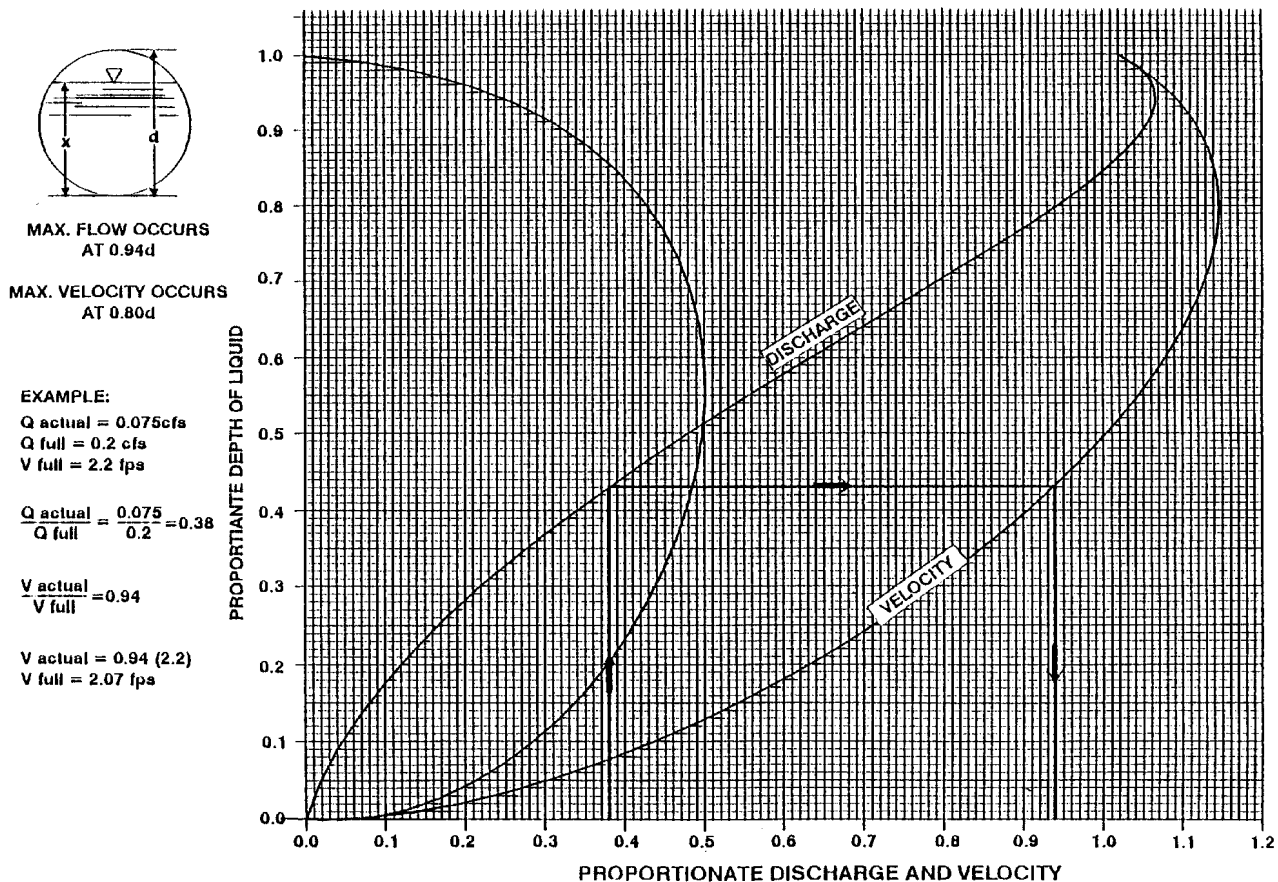


Figure 8.13. Proportionate Flow Chart.



8.4.3.3. A stabilization lagoon is a flat bottom pond enclosed by an earth dike (figure 8.14). Operating liquid depth has a range of 2 to 5 feet with 3 feet of dike freeboard. A minimum depth of 2 feet is required to prevent growth of rooted aquatic plants. Operating depths greater than 5 feet can create odorous conditions because of anaerobic bottom conditions. Influent lines discharge near the center of the pond and the effluent usually overflows in a corner on the windward side to minimize short-circuiting. Where multiple lagoons are used, they should be capable of being operated individually, in series, or in parallel. If the soil is porous, it will be necessary to seal the dikes. If a producing aquifer underlies the lagoon, it may also be necessary to seal the bottom of the lagoon. A commonly used sealing agent is bentonite. Flexible membranes may also be used.

8.4.3.4. In multiple lagoon installations, the sequence of lagoon operation is regulated to provide control of the treatment process. Operating lagoons in series generally increases BOD removal by preventing short-circuiting. Parallel operation may be desirable to distribute the organic load and avoid potential odor problems. Most stabilization lagoons emit odors occasionally. The lagoons should be located as far as practicable from the base and on the leeward side so that prevailing winds are away from the base. Lagoons treating only domestic wastewater normally operate odor free.

8.4.3.5. Figure 8.14 also lists the requirements for stabilization lagoons for various base sizes. Construction details are shown in figure 8.15. Excavation requirements for the lagoons are based on balanced cut and fill.

8.4.3.6. In areas where it is impossible to discharge wastewater off base, evaporation lagoons will have to be constructed. Because of the large construction requirements, evaporation lagoons should only be used as a last resort. Evaporation lagoons for the different base sizes are presented in table 8.2.

8.4.3.7. Evaporation is dependent upon the net evaporation rate and surface area available for evaporation. The evaporation lagoons sized in this chapter are based upon a net evaporation rate of 46 inches per year and a wastewater flow rate of 14 gallons per person per day. Figure 8.16 can be used to calculate lagoon requirements for other net evaporation rates.

8.4.3.8. Evaporation lagoons should be constructed in increments. Table 8.3 shows the time required for each of the lagoons to fill. The time varies because as the lagoon area increases, the amount of water being evaporated increases, thus decreasing the net flow rate. For the 1,100-person base the first lagoon will fill in 46 days but the eighth lagoon will not fill until 932 days. Obviously, lagoons should not be constructed if they will not be used during the anticipated deployment time frame. The lagoon construction sequence in figure 8.17 should be followed to minimize construction requirements.

8.4.3.9. Where less than one gallon per hour is discharged from a shelter supplied with water for drinking or testing purposes, a dry pit (French) drain would adequately serve the area. The drain can be constructed using a 55-gallon drum with the top and bottom removed, set level in the ground, and filled with rocks. No human or solid wastes should be discharged into the dry pit drain.

Figure 8.14. Wastewater Stabilization Lagoon.

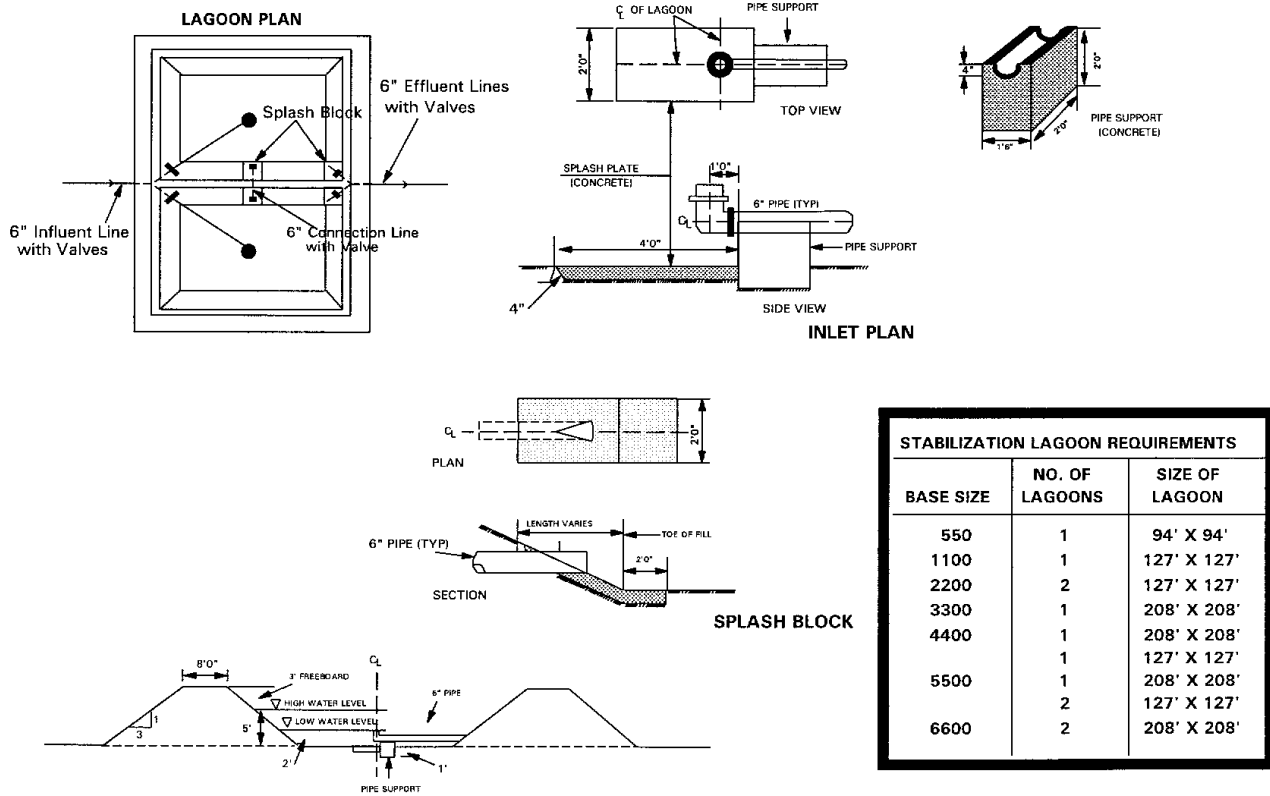
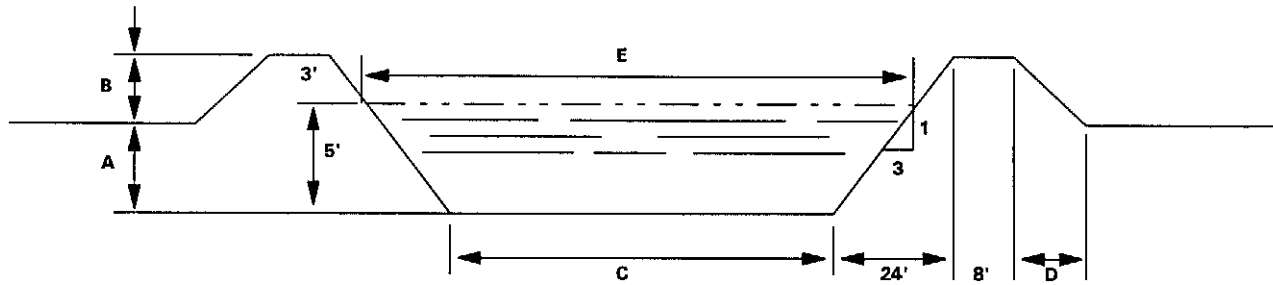


Figure 8.15. Stabilization Lagoon Construction Details.



LAGOON SIZE	A*	B	C	D	E
94' X 94'	4.6'	3.4'	64'	10.2'	94'
127' X 127'	4.0'	4.0'	97'	12.0'	127'
200' X 200'	3.0'	5.0'	178'	15.0'	208'

*Shows depth of cut from original surface for balanced cut and fill, on level ground.

Table 8.2. Lagoon Requirements.				
BASE SIZE	WASTEWATER (GPD)	LAGOON AREA REQUIRED (SF)	NO. OF LAGOONS	DIMENSIONS AT 5' DEPTH
550	7,700	100,000	9	120' x 120'
1100	15,400	200,000	9	164' x 164'
2200	30,800	400,000	9	226' x 226'
3300	46,200	600,000	9	273' x 273'
4400	61,600	800,000	9	313' x 313'
5500	77,000	1,000,000	9	348' x 348'
6600	92,400	1,200,000	9	380' x 380'

Figure 8.16. Lagoon Area Requirement.

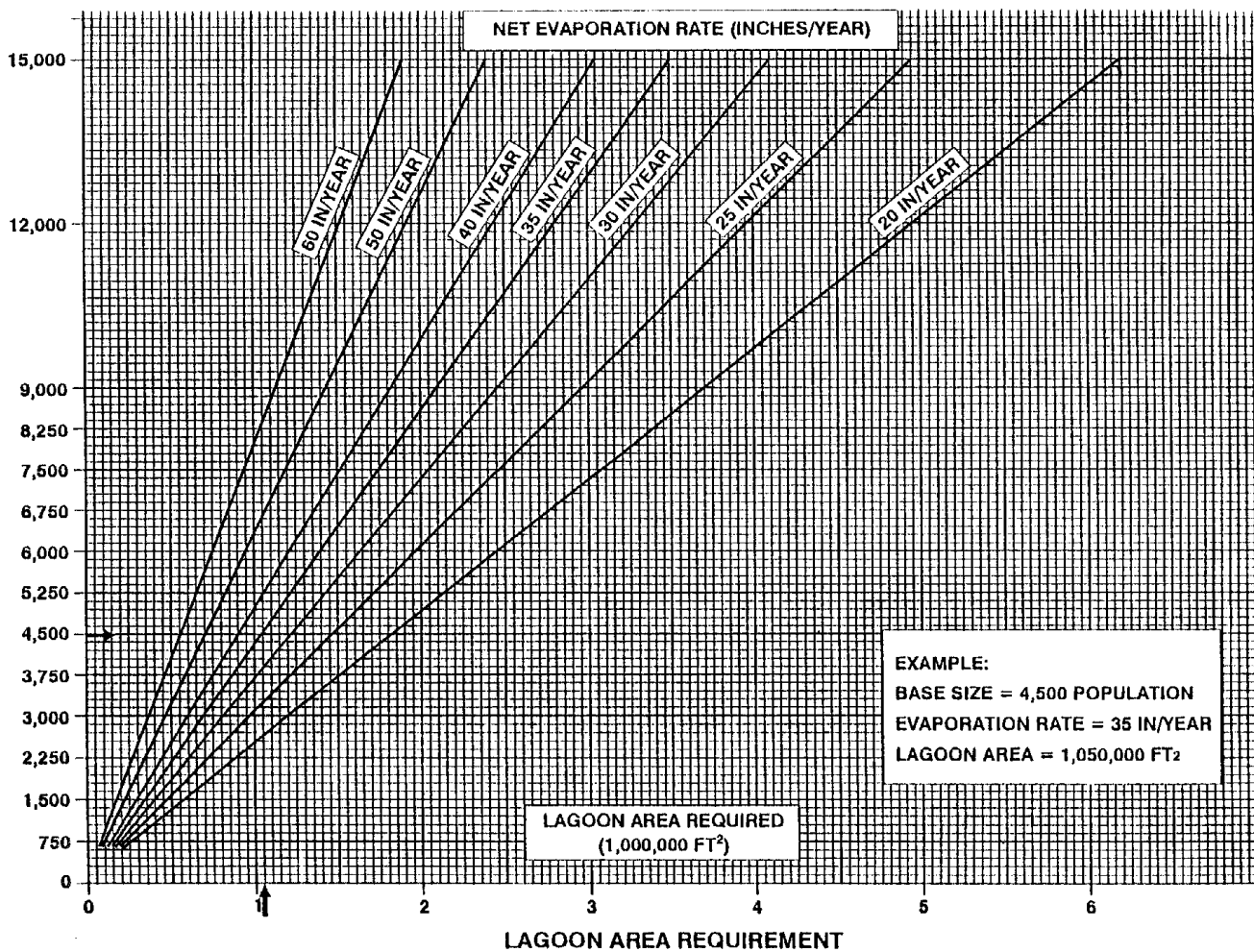
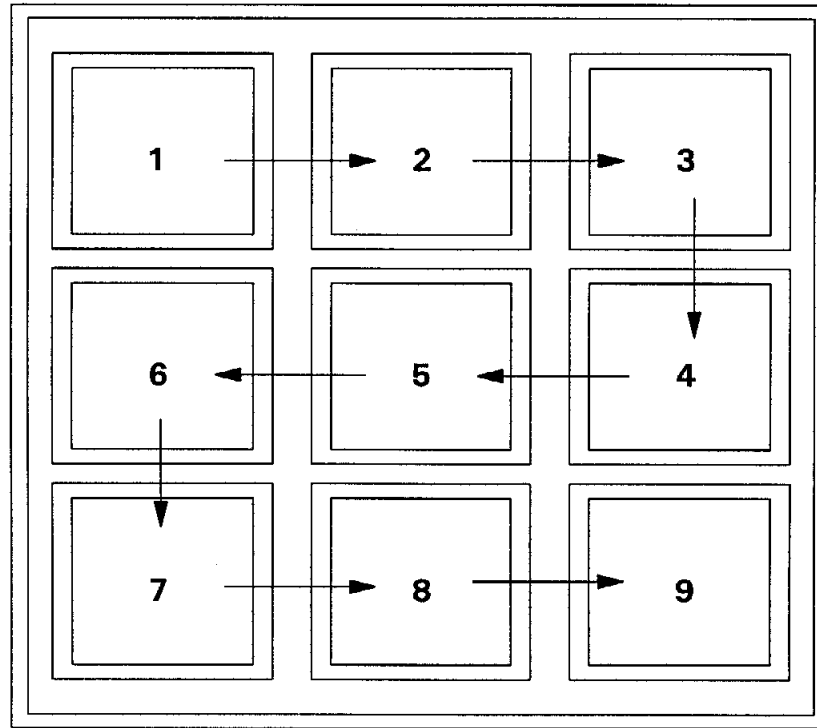


Table 8.3. Time Required to Fill Evaporation Lagoons.									
BASE SIZE	1	2	3	4	5	6	7	8	9
1100	46	99	161	233	324	445	617	932	--
2200	50	108	175	255	353	484	674	1032	--
3300	52	111	180	263	365	500	699	1059	--
4400	53	114	184	269	375	514	721	1119	--
5500	53	115	186	271	378	518	730	1133	--
6600	54	116	188	275	383	525	737	1145	--

NOTES: Based on 14 gallons of wastewater per person per day.
 Net evaporation rate of 46" per year.
 Lagoons are 5' deep with dike walls that slope at 3:1.

Figure 8.17. Lagoon Construction Sequence.



CONSTRUCT LAGOONS AS REQUIRED

8.4.3.10. Reverse osmosis water purification units (ROWPU) produce a brine water discharge that must be disposed of. The lagoons in this chapter have not been sized to accept the ROWPU brine water. The brine water must be disposed of by returning it to the source, if the source is a body of water. If the source of water is a well, some other method of disposal must be found. The ROWPU brine water flow rate varies depending upon the source water being treated but can be as high as twice the amount of potable water being produced (see chapter 7).

8.4.3.11. Wastewater from kitchens must be treated to remove grease before entering the collection system. Construction details for typical grease traps supporting kitchen facilities are presented in figure 8.18. The single-drum grease trap should be used for the old Harvest Eagle kitchen. The larger version must be used for the Harvest Falcon kitchen (feeding capacity 1,100).

8.4.4. Wastewater Collection Operations. During the initial stages of bare base establishment, latrine facilities will generally be expedient types or a combination of expedient types and field deployable units contained in the Harvest Falcon system. While you should not plan on having all field deployable latrines arrive early in the airlift flow, over the course of the first several days of the deployment such units should become more and more plentiful. As these units are set up, the expedient latrine facilities would be closed. Collection of the wastewater from the holding tanks in these units is accomplished using a wastewater disposal trailer (figure 8.19). The trailer consists of a 1,000-gallon tank and a vacuum pump powered by a 12-hp gasoline engine. The vacuum pump removes air from the tank causing suction through the pickup hose. Large material can be removed in this way and not damage the pump. To empty the unit, the pump is reversed and the tank pressurized, thus forcing out the contents. For planning purposes the wastewater disposal trailers can be assumed to make 15 trips a day and thus can dispose of 15,000 gallons per day of wastewater. Latrines should be emptied daily.

8.4.4.1. Other facilities that produce wastewater must have pits constructed to collect the wastewater. Facilities that produce relatively small quantities of wastewater should have a pit that holds 1,000 gallons. Facilities that produce larger amounts of wastewater should have a 2,000-gallon pit. Details for construction of these pits are shown in figure 8.20 and table 8.4. The wastewater disposal trailer is also used to empty these collection pits.

8.4.4.2. Wastewater from the disposal trailer should be emptied in uninhabited areas downwind from the base where contamination of drinking water sources is not possible. Dumping locations must be carefully considered since waste disposal in this manner may continue several days until the more permanent collection system with associated lagoons has been placed in at least limited service. Once the first lagoon has been constructed, wastewater can be emptied into it.

8.4.4.3. The information in table 8.5 is presented as a guide for estimating the quantities of wastewater generated under initial bare base conditions (prior to the entire collection system being installed). These quantities are less than those in table 8.1 because the water system will not be established and less water will be available. Less water will be used for showers and personnel hygiene.

Figure 8.18. Kitchen Facility Grease Traps.

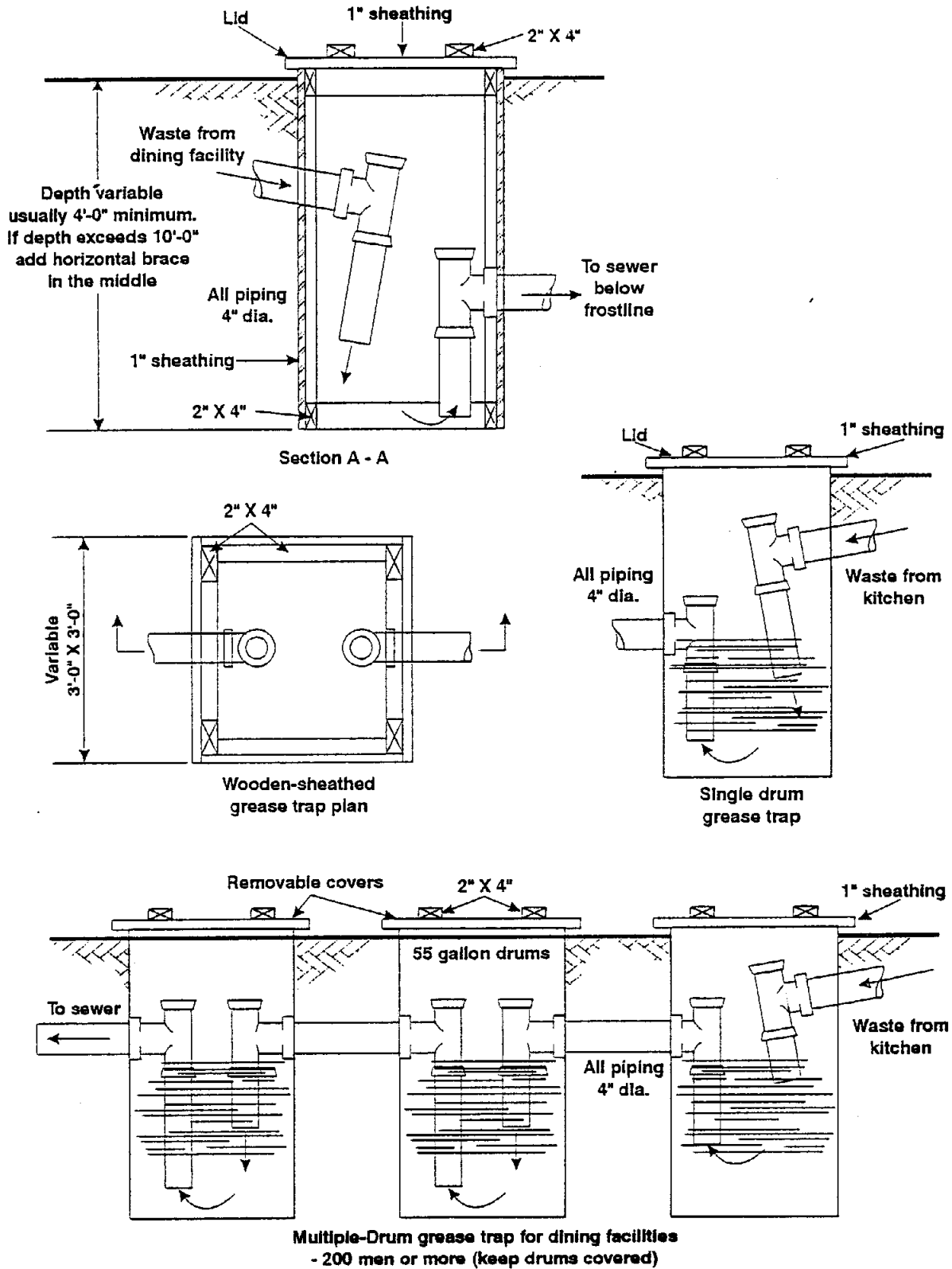
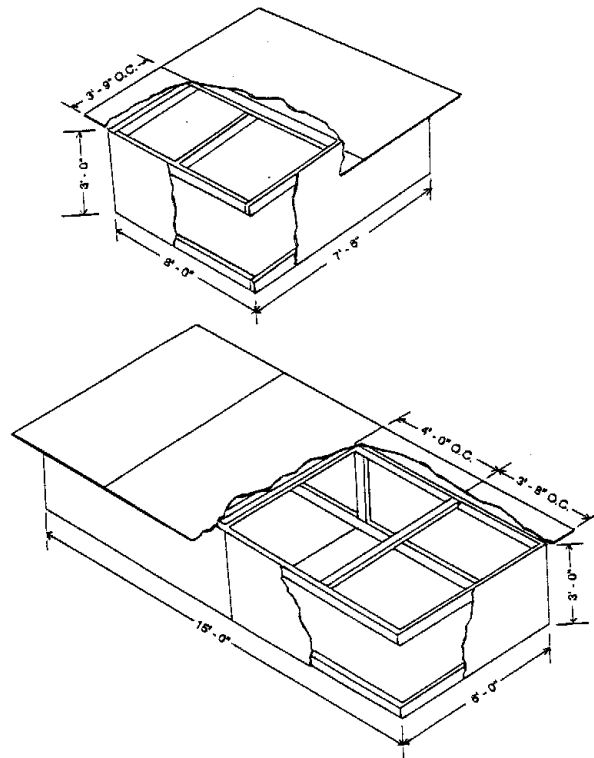


Figure 8.19. Wastewater Disposal Trailer.



Figure 8.20. Construction of Wastewater Collection Pit Boxes.



8.4.4.4. Once basic wastewater collection and sanitation facilities have been provided, attention may be directed toward installing the piping, lift stations, valves, etc. contained in the Harvest Falcon wastewater system package. Installation of these components, while not technically difficult, will be time consuming due to the distances, trenching, berming, and excavation involved. Additionally, the same personnel responsible for installation of the wastewater system, are also responsible for installing the normally more important water distribution system. Furthermore, some personnel will be siphoned off to support ROWPU operation and wastewater disposal functions. The bottom line is you have to be prepared to operate with field deployable latrines and disposal trailers for an extended time since you will have several concurrent competing beddown demands vying for your people.

Table 8.4. Bill of Materials for Wastewater Collection Boxes.			
1,000 GALLON PIT BOX			
	DESCRIPTION	NO. REQ'D	REMARKS
A	1/2" x 6'-0" x 7'-6"	1 EA	Floor
B	1/2" x 3'-0" x 7'-6"	2 EA	Side Panel
C	1/2" x 3'-0" x 6'-0"	2 EA	End Panel
D	2 x 4 x 7'-6"	4 EA	Framework
E	2 x 4 x 5'-8 3/4"	4 EA	Framework
F	2 x 4 x 5'-8 3/4"	1 EA	Brace*
	15' x 15' Sheet Plastic	1 EA	Liner
	Nail 6d	1.00 lb	
	Nail 10d	1.00 lb	
2,000 GALLON PIT BOX			
	DESCRIPTION	NO. REQ'D	REMARKS
A	1/2" x 6'-0" x 7'-6"	2 EA	Floor
B	1/2" x 3'-0" x 7'-6"	4 EA	Side Panel
C	1/2" x 3'-0" x 6'-0"	2 EA	End Panel
D	2 x 4 x 15'-0"	4 EA	Framework
E	2 x 4 x 5'-8 3/4"	4 EA	Framework
F	2 x 4 x 2'-4 3/4"	2 EA	Upright
G	2 x 4 x 5'-8 3/4"	3 EA	Brace*
H	1/2" x 4'-0" x 8'-0"	4 EA	Cover
	15' x 25' Sheet Plastic	1 EA	Liner
	Nail 6d	1.50 lb.	
	Nail 10d	2.00 lb.	
*LINE BOX WITH PLASTIC BEFORE INSTALLING BRACES			

Table 8.5. Wastewater Volumes-Initial Beddown.			
PURPOSE	QUANTITY (gpd)	QUANTITY TO BE DISPOSED (gpd)	COMMENTS
Drinking	4.0	2.0	1/2 of drinking water
Personal Hygiene	2.7	1.7	Portion of personal hygiene
Showers	1.3	1.3	100% becomes waste
Food Preparation	3.0	2.0	Only kitchen clean-up considered
Vehicles	0.3	0.0	No wastewater expected
Hospital	1.0	1.0	100% becomes waste
Heat Treatment	1.0	0.0	No wastewater expected
Construction	1.0	0.0	No wastewater expected
Graves Registration	0.2	0.0	No wastewater expected
Laundry	2.0	2.0	100% becomes waste
Aircraft Cleaning	2.0	0.0	No wastewater expected
Loss Factor	1.5	0.0	No wastewater expected
TOTAL	20.0	10.0	

8.5. Solid Waste Disposal. Solid waste must also be collected and disposed of. For planning purposes, four pounds per person per day of solid waste will be generated. This includes garbage (wastes from preparation and serving of food), rubbish (paper, cartons, boxes, cans, etc.), ashes, and industrial wastes. Approximately one pound per person per day of human waste

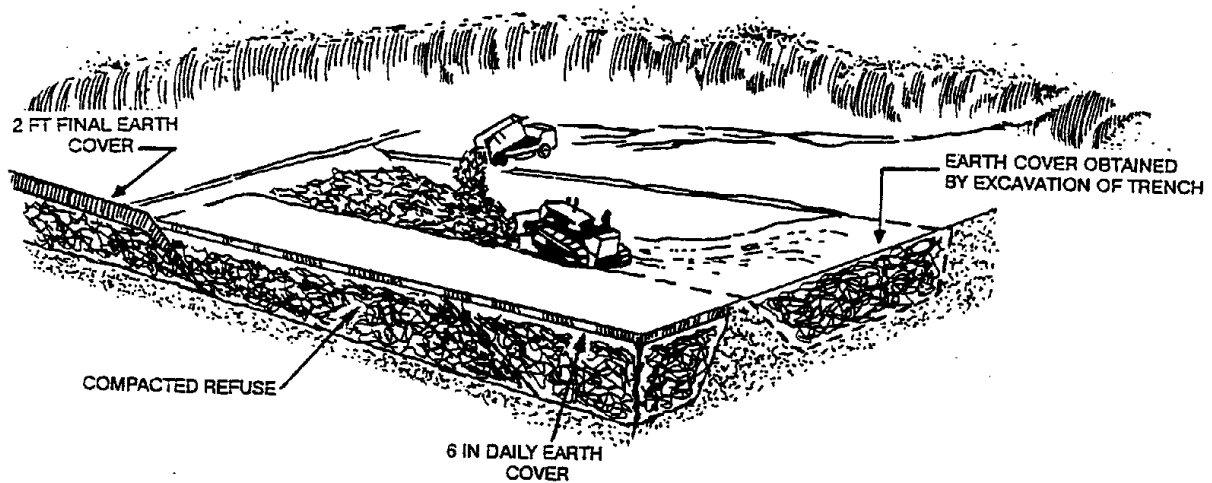
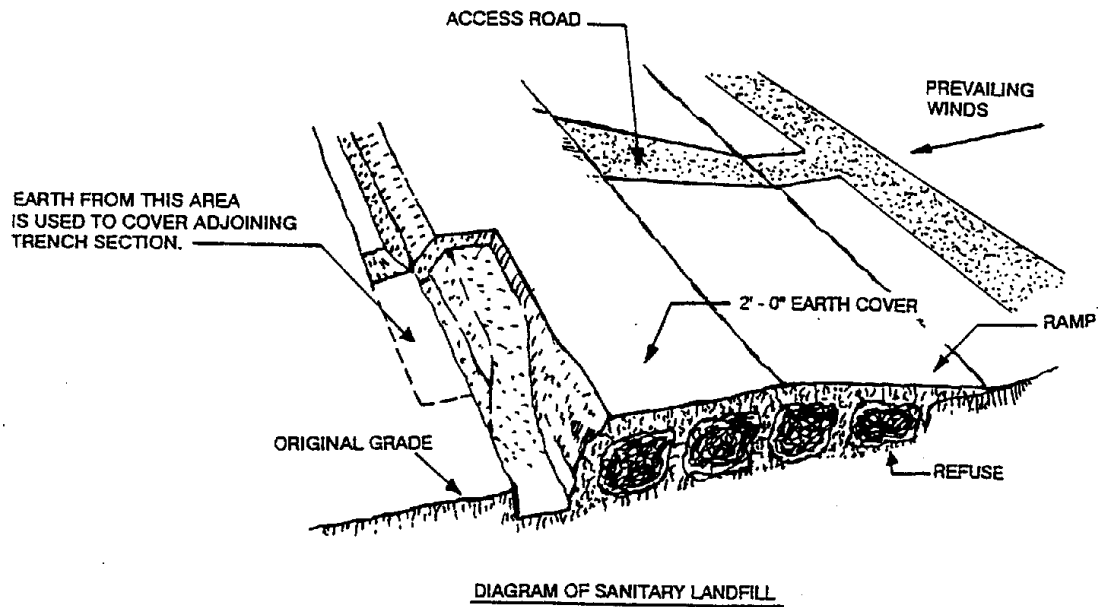
will be generated. Consideration should be given to burning as much solid waste as possible since this reduces the volume considerably. The remainder must be buried in a landfill. In most situations it is highly advisable to obtain host nation approval before starting large scale solid waste burning or burying operations

8.5.1. Landfill Operations. Uncompacted solid waste in general weighs about 200 pounds per cubic yard. When compacted into a landfill it weighs 700 to 1,000 pounds per cubic yard. For example, an 1,100-person base would generate about 4,400 pounds per day of solid waste. Uncompacted, the waste would have a volume of 22 cubic yards. A dump truck with a 5-cubic yard capacity would need to make five trips to carry a day's waste to the disposal site. Daily burial at the landfill would be between 4.4 and 6.3 cubic yards of compacted waste per day.

8.5.1.1. A typical trench method of landfill operation is shown in figure 8.21. A bulldozer digs a trench that waste is dumped into. The bulldozer spreads and compacts the waste. At the end of the day the bulldozer covers the waste with six inches of earth cover. As a trench is abandoned it should be covered with two feet of final earth cover and its boundaries marked.

8.5.1.2. To minimize the possibility of underground pollution, you should follow these recommendations when siting a landfill:

Figure 8.21. Trench Method Construction of Sanitary Landfill.



8.5.1.2.1. Do not build on exposed rock strata. Keep a minimum of 30 feet clay-till overburden between strata and refuse, unless studies indicate that a lesser depth is satisfactory. Locate fill at least 500 feet from wells, unless studies indicate that subsurface seepage is not imminent.

8.5.1.2.2. Do not place garbage and refuse in mines or other areas where resulting seepage or leaching may carry waste to water-bearing strata or wells. Remember that chemical pollution may emanate from a fill and probably will travel for long distances as compared to organic and bacterial pollution travel.

8.5.1.2.3. Do not locate sanitary fills on or near springs.

8.5.1.2.4. Locate the landfill in an area of stable soil and downwind from the installation. Avoid areas of sand dunes or other mobile earth deposits.

Chapter 9

BARE BASE FACILITIES

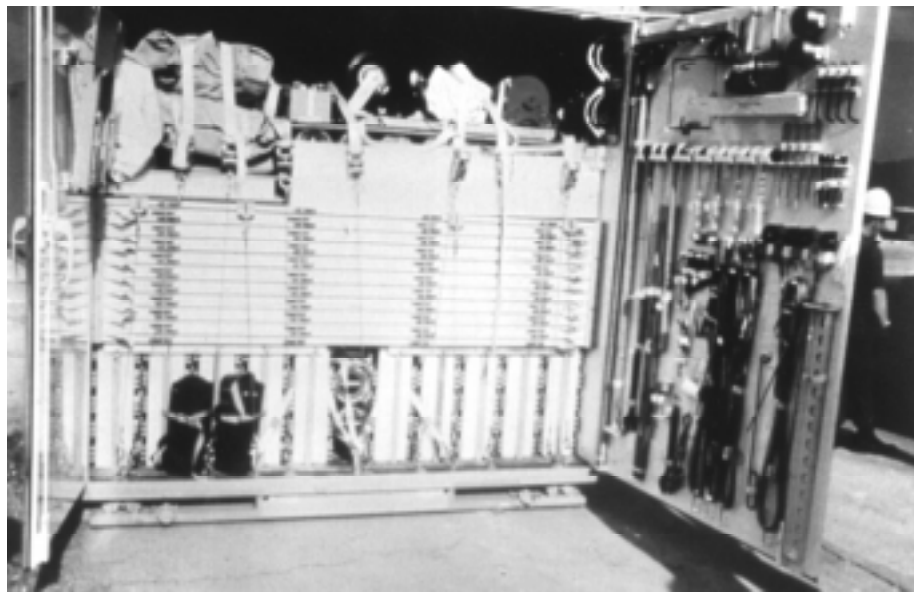


9.1. Introduction. Modular, expandable, and fabric covered shelters and canvas tents provide structures needed on a bare base for billeting, shops, hangars, and storage. All expandable facilities and tents can be set up for immediate use or packaged for redeployment by the same people who will use them. Bare base shelters are made of lightweight materials which provide virtually no protection against direct and indirect fire weapons and munitions. Consequently, in high threat areas these shelters must be dispersed, hardened to the maximum extent possible by means of sandbag or other expedient revetment walls and, in some instances, protective shelters may have to be constructed to obtain the required degree of survivability.

9.2. Overview. This chapter provides a description of the different shelters available in the Harvest Falcon and Harvest Eagle equipment packages. The chapter also covers the special handling procedures required for hardwall shelters. Supporting this chapter for planning purposes is a facilities matrix in attachment 13 which depicts Harvest Falcon facility requirements for the hypothetical base populations and assigned aircraft presented in chapter 4.

9.3. Harvest Falcon Shelters.

9.3.1. General Purpose Shelter (GP). The general purpose shelter (Part No. 3145000-001-101) supports such functions as shops, storage, and multipurpose use (figure 9.1). The basic structure consists of rigid honeycomb panels and I-beams connected to form a series of arches. Each arch is made up of six panels and 12 beams, is self-supporting, and is erected independently. To ensure rigidity, the arches are connected to each other with adjustable spacers. The shelter has windows and rigid doors. One end wall is provided with personnel doors. On the opposite wall, truck doors give access to service equipment. Lighting and service outlets are provided through a distribution panel and cable arrangement on each side of the shelter. The shelter can be erected rapidly on a prepared surface compatible with the intended use of the shelter and floor with a crew of six people (engineer personnel) in 15 to 20 hours, depending on whether or not a floor is installed. A membrane floor, constructed of flexible heavy duty fabric, is an optional feature that may be installed in the shelter. In addition to the membrane floor, a second lightweight flooring system has been included in the Harvest Falcon package for GP shelters. This flooring consists of rigid panels that fit together with seals. Removable panels in the shelter allow installation of a heating and air conditioning unit. Shelter erection tools are provided and located in marked containers. The overall size of the shelter is approximately 31 feet by 48 feet by 12 feet. It packages into a container 8 feet by 8 feet by 10 feet (figure 9.2). There are three of these GP shelters in the Harvest Falcon housekeeping set, four in the industrial operations set, 11 in the initial flightline support set, and four in the follow-on flightline operations set.

Figure 9.1. General Purpose Shelter.**Figure 9.2. Packaged General Purpose Shelter.**

9.3.2. Expandable Shelter Container (ESC). The expandable shelter container (Part No. 3096010-001-101) is used primarily for flightline and industrial shops (figure 9.3). The basic structure is constructed of sandwich panels with structural framing and windows of cast and extruded aluminum. When expanded, the ESC measures approximately 8 feet by 13 feet by 21 feet and weighs 4,220 pounds when shipped without an internal payload. When packaged, the unit is 8 feet by 8 feet by 13 feet (figure 9.4). The ESC unit unfolds from a packaged center structure to an expanded shelter mode. The components that form the final expanded structure are hinged and folded into the center structure so that the unit may be expanded without removing whatever payload might be in the container. Panel inserts in one of the swing-out walls can be removed to connect heating and cooling equipment. The panels are made of resin-impregnated paper honeycomb, bonded between parallel sheets of aluminum. Double doors (cargo doors) are installed in one end wall of the center section and a personnel door in the other end wall. Double pane windows in the walls of the expandable sections are nonopening, shatterproof, heat resistant, and equipped with blackout curtains. A complete 3-phase electrical installation is provided with each shelter. The shelter can be

erected on a site where the slope of the terrain does not exceed 18 inches over the projected floor area. Leveling jacks are used to level the structure. The ESC can be erected with a crew of four to six people in 2 hours. There is one ESC in the Harvest Falcon housekeeping set, nine in the industrial operations set, 14 in the initial flightline support set, and three in the follow-on flightline operations set.

Figure 9.3. Expandable Shelter Container.



Figure 9.4. Packaged Expandable Shelter Container.



9.3.3. Aircraft Maintenance Hangar (ACH). The 76-foot aircraft maintenance hangar (Part No. 3141000-001-101) is used for most on-aircraft maintenance functions (figure 9.5). It consists of a series of free standing arches formed from individually shipped aluminum beams and honeycomb core and aluminum skin panels. The beams and panels are locked together at ground level to form an arch section. The sections are double-pinned together at the beam ends and progressively lifted with an A-frame hoist to form an arch. Additional arches are erected using spacers to assure proper relative location. Space between arches is covered with fabric flashing. The clam-shaped end closures are made of fabric. The four shipping containers are positioned to make vestibule-like personnel entrances/offices. There is no floor with the package. The floor can be of existing concrete, AM-2 matting, or locally supplied materials. The ACH structure comes complete with 3-phase electric wiring and openings for ducts to interface with the bare base electric and heat systems. The first choice for a site is on, or close to, an airfield apron. If use of an apron site is impractical, a hard surface (approximately 125 by 125 feet) capable of withstanding aircraft weights should be selected. The selected site terrain should be smooth, firm, well drained, and relatively free of surface rock or stone. The slope of the terrain must be within the dimensional tolerances of a maximum slope of 18 inches over the projected floor area. When erected, the hangar is 25 feet high at the center, 77 feet wide, and 125 feet long with the doors closed. The hangar is shipped in four equal size containers, each measuring approximately 10 feet by 8 feet by 8 feet. When the ACH is erected, these empty containers become part of the ACH (used primarily as offices; two of the containers are shown in figure 9.5). The ACH can be erected by 12 people in about two days. The same number is needed to dismantle and repack the ACH. Erection of ACHs is accomplished by RED HORSE or personnel from the 49th Material Maintenance Group from Holloman AFB. Two hangars are included as part of the initial flightline support set with an additional one included in the follow-on flightline operations set.

9.3.4. Expandable Personnel Shelter (EXP). The expandable personnel shelter (figure 9.6) is being dropped from the Harvest Falcon asset inventory. A few, however, may still be in use until they become irreparable; therefore, a brief discussion of them is presented. The EXPs primary use is for administrative type functions. The shelter's container walls, ceilings, and floor are sandwich panels or aluminum sheets with honeycomb cores. The expanded walls and ceiling are accordion-pleated foam board panels. When expanded, the shelter size is approximately 14 feet by 8 feet by 32 feet. When collapsed, it functions as a shipping container approximately 3 feet by 8 feet by 13 feet and weighs 2,875 pounds without an internal payload. During shipment, three units are packaged and shipped together (figure 9.7). A 3-phase electrical power system is provided with each shelter and interfaces with the bare base electrical system. Heating and cooling equipment is easily connected. Blackout curtains are included for the windows, doors, and fan. The shelter can be erected on a site where the slope of the terrain does not exceed a longitudinal and lateral slope of 11 inches over the projected floor area. Four large axial jacks are used to level and support the center structure and scissor jacks are used to level and support the expanded sections. The EXP can be erected with a crew of four to six people in 2 hours.

Figure 9.5. Aircraft Maintenance Hangar.



Figure 9.6. Expandable Personnel Shelter.



Figure 9.7. Packaged Expandable Personnel Shelter.



9.3.5. Tent Extendible Modular Personnel (TEMPER). By far the most numerous facility in the Harvest Falcon and Harvest Eagle packages, the TEMPER tent is a modular soft shelter supported by an aluminum frame structure (figure 9.8). The tent fabric is made of a synthetic material. Its primary use is for troop billeting (12 personnel per tent) but it also supports other functions such as shops and administrative space. The tent comes with roll up windows, mosquito netting, and a fly sheet (waterproof material that attaches above the tent top and allows free movement of air between the fly sheet and tent top). The tent comes in 8 by 20-foot sections that fasten together; the nominal tent size is 32 by 20 feet. Also included are a white inner liner for insulation within the tent and a fabric floor. For special adaptations, solid doors and entry vestibules are available. An electrical wiring kit provides lights and convenience outlets. The TEMPER tent can be heated and cooled as required and a fabric plenum is provided to direct air flow. This shelter can be easily erected by ten people in less than two hours. In a basic Harvest Falcon 1,100 person/one aircraft squadron configuration 92 tents are provided for billeting purposes and 56 support other base functions.

9.3.6. Frame Supported Tension Fabric Shelter (FSTFS). The FSTFS is hangar-like structure fashioned by stretching a fabric skin over a series of metal arches (figure 9.9). It is used to support functions requiring large floor spaces such as supply storage, vehicle maintenance, and certain aircraft maintenance shops. The most common sizes in the Harvest Falcon package are 4,200 SF and 8,400 SF. These facilities are erected by RED HORSE or the 49th Material Maintenance Group from Holloman AFB. There are seven of these facilities in the industrial operations set and four in the initial flightline support set. FSTFSs are gradually being replaced by dome shelters which provide a bit more versatility in use. Besides being able to serve as shops and storage facilities, they can function as aircraft hangars, if necessary. These dome shelters are 65 feet long, 32 feet wide, and 24 feet high at the arch apex. Shipped in four containers, a dome shelter can be erected in about 32 hours by a crew of eight people.

9.3.7. Shower/Shave Unit. The portable facility consists of a four-section shower element and four separate washstands which jointly form the shower/shave unit. At least four units are included in the housekeeping set of the Harvest Falcon package; four units also are contained in the 1,100-person Harvest Eagle sets. These units come with their own TEMPER tents.

9.3.7.1. The portable shower consists of six separate but identical and interchangeable modules. Each module consists of a pallet-like shower base pan with integral drains and fittings to connect the drain plumbing. Each shower module has two shower nozzles mounted on a surrounding framework which serves as a support for the vinyl fabric shower enclosure (figure 9.10). The complete shower system includes interconnecting hoses among the six modules for both water inlet and draining, an M-80 water heater and pump for hot water supply, and a pump with hose for removal of wastewater.

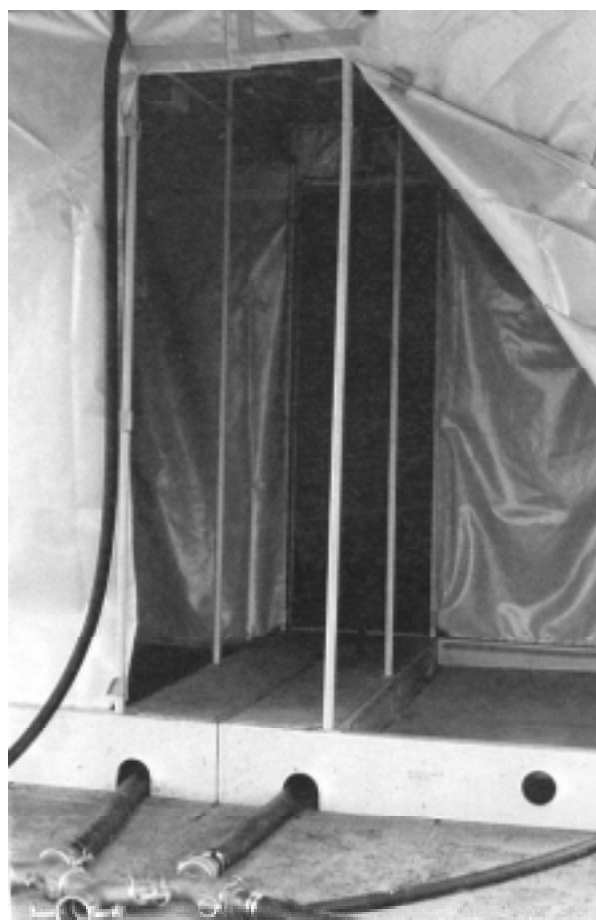
Figure 9.8. TEMPER Tent.



Figure 9.9. Frame Supported Tension Fabric Shelter.



Figure 9.10. Shower Unit.



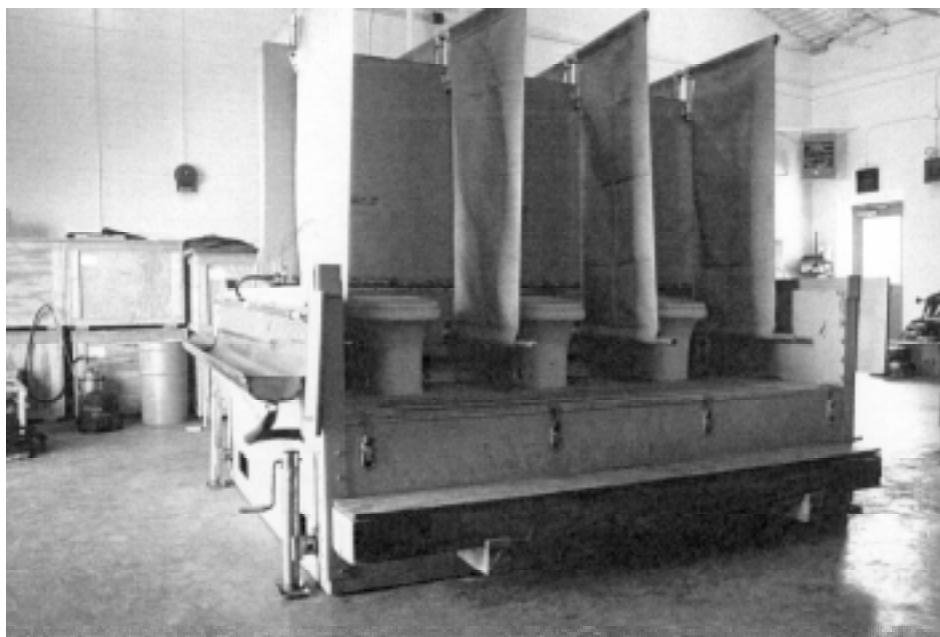
9.3.7.2. Each shave facility consists of a three-bowl washstand and a mirror with attached light fixture (figure 9.11). The washstand features folding legs and contains all required plumbing. Four washstands (a total of 12 bowls) will be located with each field shower (two on each side).

9.3.8. Field Deployable Latrine. The field deployable latrine is included in both Harvest Falcon and Harvest Eagle facility packages. The latrine consists of three toilets and a urinal trough mounted above a 135-gallon water tank and a 180-gallon waste tank (figure 9.12). Four field deployable latrine units constitute one Harvest Falcon/Eagle latrine package and support 275 personnel. These packages come with their own TEMPER tents.

9.3.8.1. The tanks are supported by an aluminum frame and plywood partitions. There are privacy screens between the toilet stools and the urinal. A pressurized water system operating on 115-volt AC power supplies water for flushing toilets. The vent pipes, curtains and frame dismantle and the urinal board folds down to provide a shipping package 88 inches wide, 104 inches long, and 42 inches high. The latrine contains an electrical outlet and comes with a 100-foot power cable. The unit is self-packaging, can be forklifted and is stackable. Tie down and lifting eyes are provided. The double stacked latrine unit is air transportable on 463L pallets. The unit weighs 1,400 pounds dry.

Figure 9.11. Shave Unit.



Figure 9.12. Field Deployable Latrine.

9.3.8.2. The latrine can be unpacked, assembled, and placed in operation by four people in 2 hours. During the early stages of a deployment, this latrine can be operated in a stand-alone mode. That is, the water tank is periodically replenished and the waste tank is emptied using the wastewater disposal trailer. Once the Harvest Falcon water and waste distribution systems are in place, the unit can be connected directly to the service lines. In a Harvest Eagle set up, the unit can be connected to the water supply system but the wastewater disposal trailer must continue to be used. For planning purposes, the field deployable latrine serves 70 male personnel or 52 female personnel.

9.3.9. Food Service Facilities. The kitchen complex serving Harvest Falcon and Harvest Eagle deployments consists of several TEMPER tents and associated kitchen equipment sized to feed 1,100 personnel. (Harvest Eagle 1,100-person kitchen package consists of two 550-person kitchens.) In a typical set up for this population size, three interconnected shelters (figure 9.13) provide space for storage, utensil washing, food preparation, serving, and dining. Services personnel normally erect all the TEMPER tents associated with the kitchen; however, engineer personnel must provide supporting utility service (electric, water, wastewater) and install some of the more complicated equipment items such as water heaters, walk-in refrigeration units, and air conditioning units. A suggested floor plan for the Harvest Falcon kitchen (often referred to as the 9-1 kitchen) is depicted in figure 9.14.

Figure 9.13. 1,100-Person Kitchen Complex.

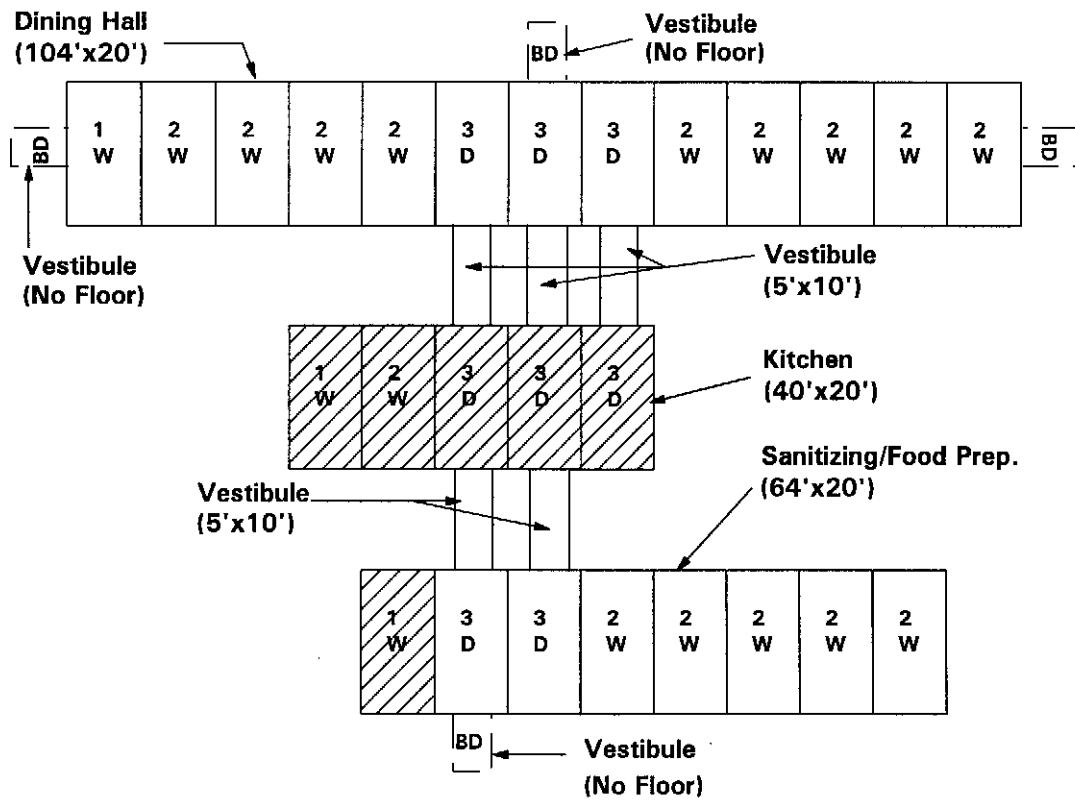


9.4. Older Harvest Eagle Shelters. There are three different types of tents associated with the original Harvest Eagle system: general purpose medium, general purpose large, and kitchen. A program for replacing these three types of tents with TEMPER tents has been underway; however, it is likely you may still encounter these older tents during deployments. Both USAFE and PACAF use these Harvest Eagle-type assets in tailored housekeeping sets (see paragraph 9.6 for further details). When tents are to be used for a long period of time they should be hardbacked. Details for hardbacking a general purpose medium tent are given in attachment 14.

9.4.1. General Purpose Medium (GPM) Tent. The GPM tent (16 by 32 feet), complete with pins and poles, is designed to be used primarily for billeting, accommodating 12 people (figure 9.15). It can be used for a variety of other functions as well. Four persons can pitch the tent in about 40 minutes.

9.4.2. General Purpose Large (GPL) Tent. The 18 by 52 feet GPL tent (figure 9.16), which also comes complete with pins and poles, is designed to be used for functions which require more room. It can billet 22 people. Six people can pitch the tent in approximately 1 1/4 hours.

Figure 9.14. Typical Harvest Falcon Kitchen Floor Layout.



FLOOR LAYOUT PLAN

LEGEND	
1	End Section
2	Extendable Frame
3	Extendable Door
	Section Frame
W	Window
D	Door
BD	Bump thru door
▨	Screen Room Ventilation

FLOOR CONSTRUCTION:

Each section is 8' x 20'

Floored vestibules are 5' x 10'

FLOOR MATERIALS:

2 x 4 x 10' @ 16" OC - 435 each

4' x 8' x 3/4" plywood - 150 sheets

12 penny nails - 75 pounds

6 or 8 penny nails - 100 pounds

Figure 9.15. General Purpose Medium Tent.



Figure 9.16. General Purpose Large Tent.

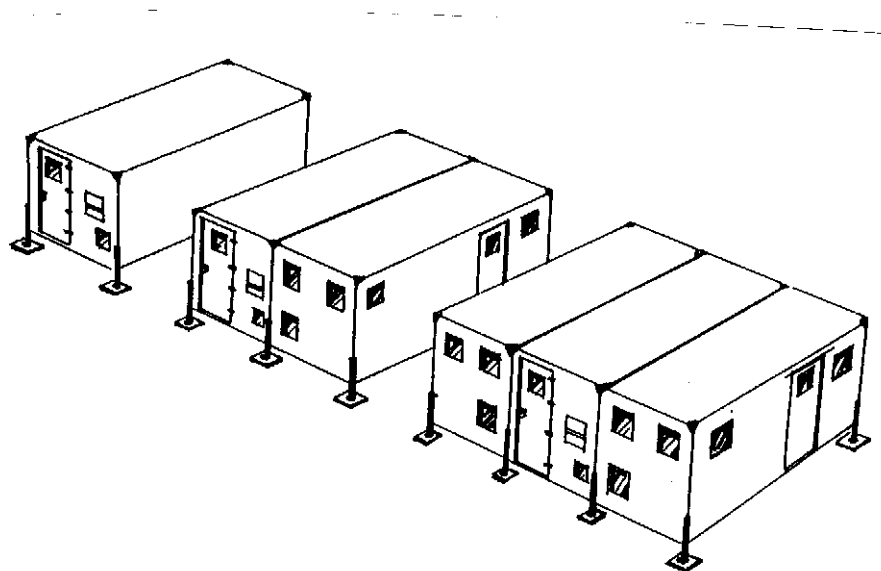


9.4.3. M-1948 Kitchen Tent. The M-1948 kitchen tent (figure 9.17) is a screened story and one half shelter (12 feet wide, 18 feet long, 9 feet high in the service section and 12 feet, 3 inches high in the stack section) for cooking and serving food. The tent can be pitched by five people in approximately one hour. When conditions permit, the tent should be pitched away from natural elevations or tall equipment that might obstruct a draft through the tent stack.

Figure 9.17. M-1948 Kitchen Tent.

9.5. ISO Shelters. ISO shelters were developed in an attempt to provide some degree of standardization in the various shelters used by the Armed Forces for mobility missions. The ISO designation for these shelters means that each structure conforms to the material handling requirements established by the International Standardization Organization (hence, ISO). Although there are not many of these types of facilities in the Harvest Falcon/Eagle programs, you may encounter some at locations supporting more than one of the military services. As depicted in figure 9.18, these shelters are either rigid (ISO 1:1), or expandable (ISO 2:1 and ISO 3:1). No special equipment is needed for setup and striking of ISO shelters; site preparation requirements are minimal.

9.5.1. ISO 1:1. The ISO 1:1 (rigid) measures 8 by 8 by 20 feet; its gross weight is 13,900 pounds (3,900 tare weight and 10,000 payload).

Figure 9.18. ISO Shelters.

9.5.2. ISO 2:1. The ISO 2:1 (one side expandable) has an interior dimension of 14 feet, 6 inches by 19 feet, 1 inch; ceiling height is 7 feet, 1 inch. The gross weight of this shelter is 15,000 pounds (tare weight is 5,500 pounds). With four people assigned to the task, erection time for the ISO 2:1 is 25 minutes.

9.5.3. ISO 3:1. With both sides expanded, the ISO 3:1 has a nominal interior dimension of 20 feet by 11 feet, 6 inches; ceiling height is 6 feet, 9 inches. Gross weight is 6,500 pounds; tare weight is 2,000 pounds. Six persons are required to erect the ISO 3:1 in 45 minutes.

9.6. Automatic Building Machines. While not included in the Harvest Falcon or Harvest Eagle packages, automatic building machines were used extensively during the Gulf War at various bare base locations. Using rolls of galvanized steel or aluminum, these machines basically produce structural building arches of various widths which are erected and crimped together at the seams. The facilities manufactured can be used for such purposes as aircraft hangars or covered storage buildings (figure 9.19). These machines can also produce straight sections which can be used for end walls. When fitted with end walls and ventilating and mechanical systems, these types of facilities can serve as shops, recreational facilities, and shelters. Some of these machines are prepositioned overseas and others are part of the equipment package belonging to RED HORSE squadrons. A trained crew of about 10-12 personnel can make and assemble a 10,000 SF facility in about a day using this trailer mounted system.

Figure 9.19. Manufactured K-Span Facility.



9.7. Theater-Unique Housekeeping Assets. Both USAFE and PACAF maintain mobile facility asset packages over and above the standard Harvest Eagle sets. These assets are now part of the bare base War Readiness Materiel (WRM) equipment and can be deployed to any regional conflict where they may be required. Besides wartime and contingency support, these asset packages could potentially also be used for disaster relief and exercise situations. These theater-unique facility packages are essentially housekeeping sets which focus on people support (275-person increments) at deployed locations. USAFE has approximately 10 sets normally stored at three locations, whereas PACAF maintains approximately 51 sets at various locations throughout the Pacific region. The contents of these sets (table 9.1) usually include such items as GPM and GPL tents; low voltage generators; water purification units; and heaters. In some cases kitchen sets are also available which provide feeding capabilities for 275 personnel. These kitchen sets include kitchen tents and food service equipment but must be provided with utility support from external sources. PACAF maintains approximately 27 of these kitchen sets at various theater locations.

9.8. Handling of Facilities. Dimensions and weight will determine the mode of transportation from the aircraft to the site of erection. Basically, the shelters must be forklifted, hoisted, or trucked from one location to another. Engineer units must ensure they have several personnel qualified on large, all terrain forklifts. Site layout actions must be well underway by the time facilities begin to arrive on base. This permits equipment operators to place facility assets correctly with respect to orientation and utility connections. More importantly, this also helps prevent handling and moving assets more than once during the initial beddown timeframe. Many Harvest Eagle and Harvest Falcon assets are transported in ship/store containers that are 90 inches high and sized for a 463L pallet. The containers have double doors on both 108-inch sides with adjustable shelves and a center divider. The containers have a tare weight of about 1750 pounds and a maximum load capacity of 10,000 pounds. They are used to ship and store such bare base assets as TEMPER tents, shower/shave facilities, 9-1 kitchens, FSTFSs, and dome shelters.

Table 9.1. PACAF/USAFE Housekeeping Set Contents (Major Items).	
EQUIPMENT ITEM	QUANTITY
ROWPU	1
3,000-Gallon Bladder	3
30-kW Generator	1
60-kW Generator	4
Floodlight Set	4
GPM Tent	28
70,000 BTU Heater	28
Cots	275
Lumber 2 x 4	9600 ft
Lumber 1 x 6	2880 ft
Plywood 1/4"	480 sheets
Plywood 1/2"	480 sheets

9.8.1. Forklift. Provisions for forklifting tines are incorporated into the base assembly of all hard wall shelters. The tines must slide into the opening provided for the forklift operation. Since EXP shelters are shipped in a triple-mode concept, the forklift must be capable of picking up this load plus any payload that might be stored within the shelter packages. The ship/store containers also have forklift tine holes.

9.8.2. Hoisting. Hoisting rings are located on each roof corner of each hardwall shelter container. When three shelters are joined in a triple-mode concept, 12 rings are available. Inboard corners of outboard shelters or outboard corners of center shelters give the best cable angles. The angle of the hoisting vehicle must be capable of hoisting the shelter and any internal payload it might contain. Ship/store containers also have external lifting rings.

9.9. Allowance Standards (AS). AS 158 is the allowance standard for Harvest Falcon assets and Harvest Eagle equipage is contained in AS 159. The facility and equipment lists presented in chapter 3 (tables 3.1 through 3.4) for Harvest Falcon sets are derived from the information contained in the AS. Be aware, however, that the allowance standard is not specific with respect to numbers and types of facilities for all functional areas. For example, the security police will likely desire a base defense operations center, sector command posts, an armory, a storage facility and protective revetments; these potential requirements are not specifically delineated in the AS. Instead, there are several facility assets that are identified as multi-purpose or common facilities and these will have to be parceled out basewide to meet the various facility demands. The commander at the deployed location will have to act as the final say in regard to facility allocation, but as engineers you must be prepared to provide advice and recommendations on facility scopes and basewide requirements based on population and numbers of aircraft. As a starting point you can use the tables in attachment 6 which summarize facility requirements for the hypothetical base populations and assigned aircraft presented in chapter 4.

9.10. Dispersed Facility Layouts. In high threat areas facilities must be dispersed. Figure 9.20 depicts typical dispersed layouts which can be used to build all facility groups, except billeting. By simply combining the appropriate number of groupings you can lay out an entire facility group in a short period of time. Use figure 9.21 for billeting areas. By combining this type of grouping, you will be able to plan an entire billeting group. Included in attachment 15 is an example of a

dispersed layout for a bare base which supports a population of 3,300. Also presented are dispersed layouts for each of the facility groups shown on the example. Using these standard layouts as a guide should greatly simplify your planning task.

9.11. Survivability Considerations. As stated at the chapter's outset, the lightweight construction of modular bare base shelters provides little, if any, protection even against small arms fire, much less the blast and fragmentation associated with indirect fire weapons and aerial munitions. While dispersal of facilities in a high threat environment is a major step toward enhanced survivability, additional measures are necessary to protect personnel and critical resources. Volume 2 of this pamphlet series highlights basic survivability knowledge for planning such enhancement measures. Included are descriptions of various weapons effects; and, natural and manmade revetting materials are identified and ranked according to their protection potential. Protective shelters are then categorized and briefly described. Detailed construction methods for structural revetments and personnel protection shelters are presented in volume 7 of this pamphlet series.

Figure 9.20. Dispersed Layout for 3, 6, 9 and 12 Facilities.

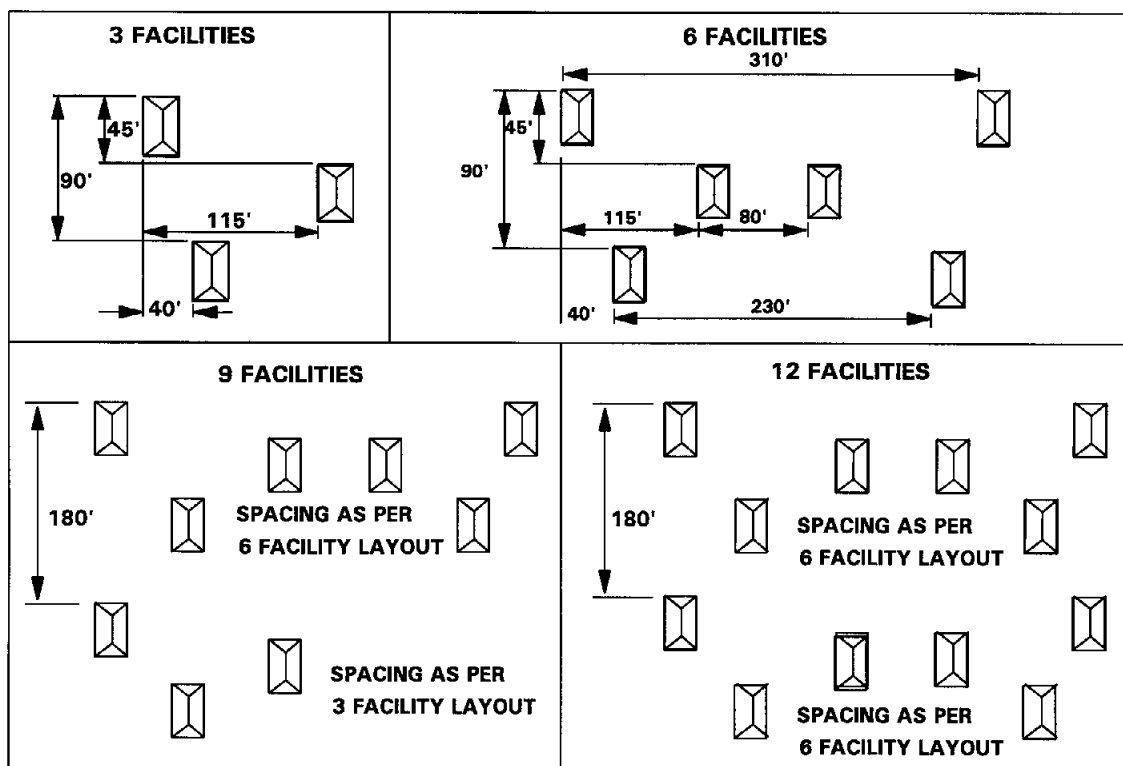
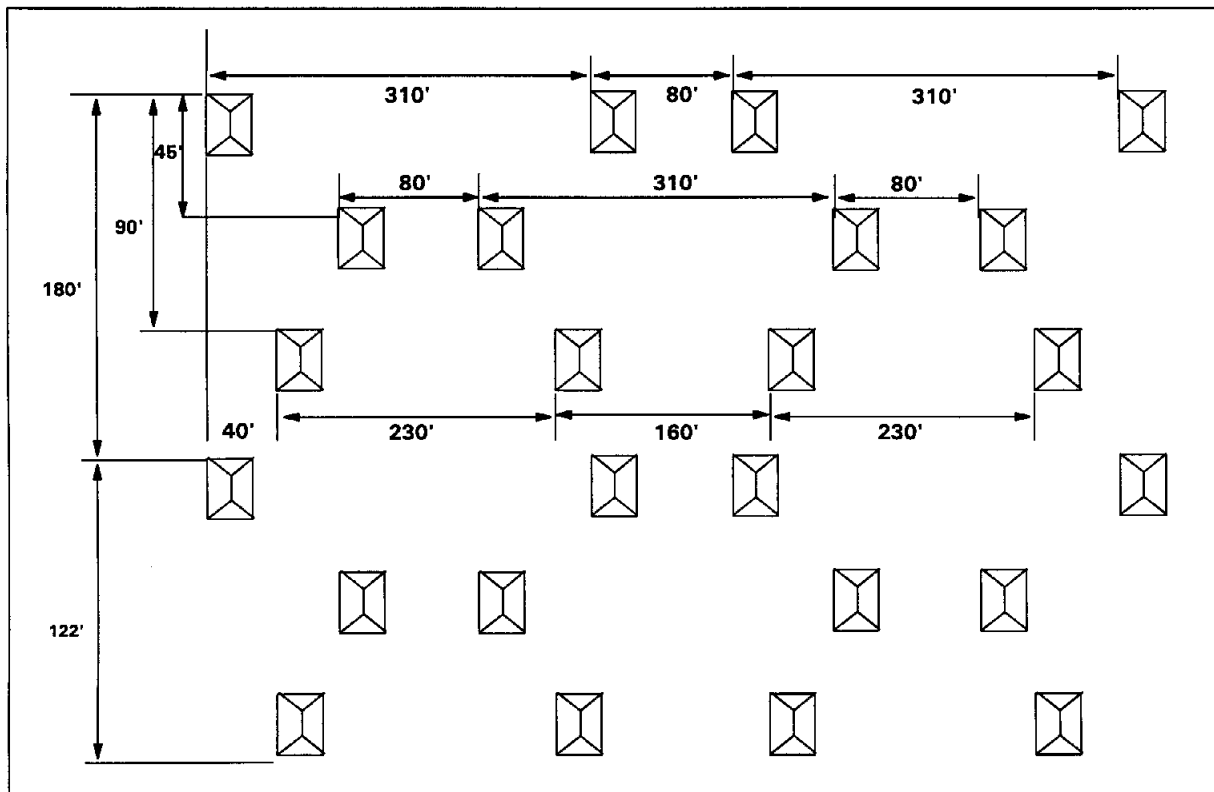


Figure 9.21. Dispersed Layout for 24 Facilities.



Chapter 10

BARE BASE ANCILLARY EQUIPMENT



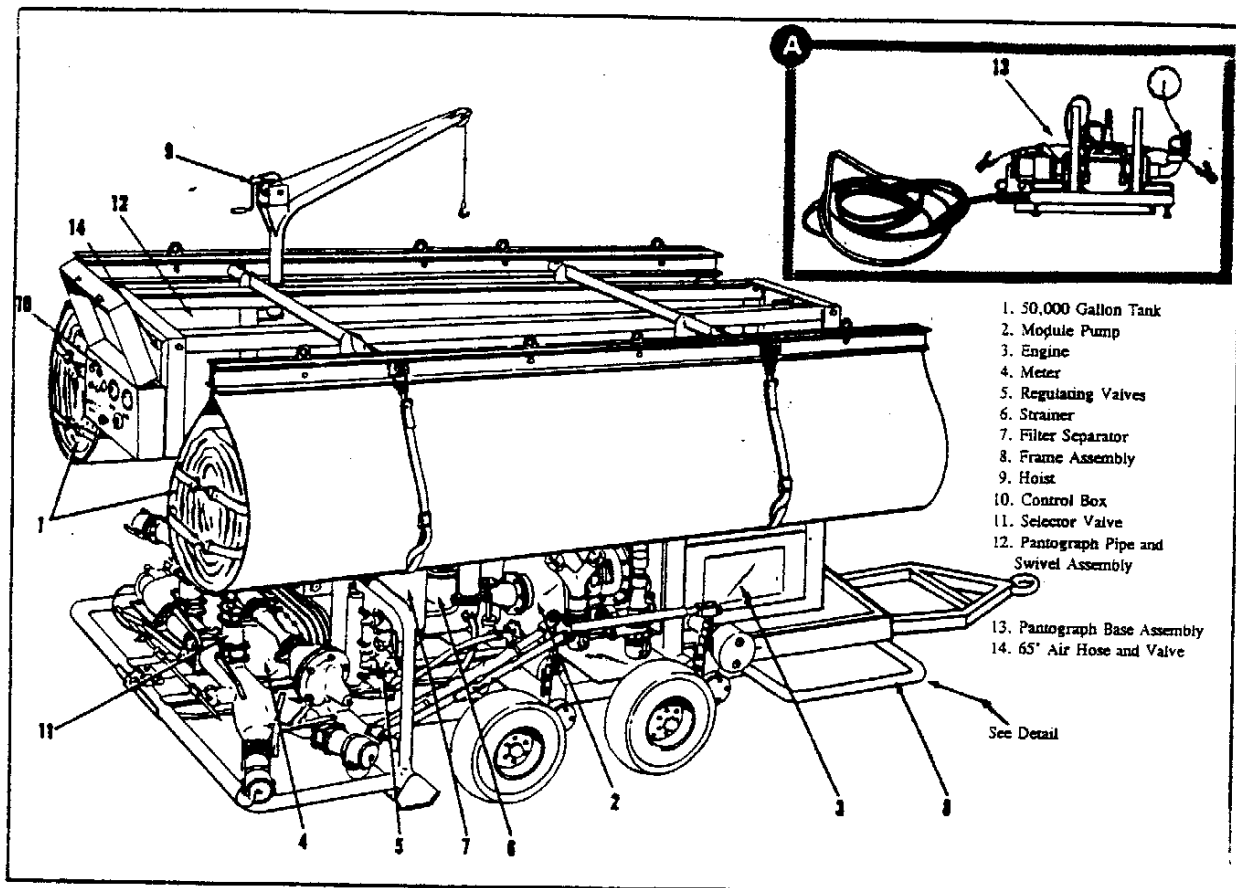
10.1. Introduction. This chapter provides descriptions of ancillary equipment and systems which the bare base civil engineer force operates or supports. This support usually involves site preparation, installation, hardening, and the provision of electrical power, fuel, water, and waste disposal.

10.2. Overview. The description of equipment and systems is of a general nature and does not cover operations or detailed procedures. This chapter is intended as a guide and ready reference for planning the additional resources required to support these ancillary equipment items.

10.3. Air Transportable Hydrant Refueling System. Minimum expedient fuel facilities at a bare base consist of six 50,000-gallon pillow tanks sited at the apron edge with the air transportable hydrant system to filter and pump fuel into the aircraft. This fueling method requires aircraft to be brought to the fueling points and engines must be shut down during refueling. The pillow tanks are resupplied directly by tanker aircraft.

10.3.1. Description. Each USAF Type A/E 32R-14 air transportable hydrant refueling system, commonly known as the R-14, consists of a fuel servicing module (figure 10.1) and two 50,000-gallon pillow tanks. The system has a pressure controlled pumping capacity of up to 600 gpm. The pump is driven by a multi-fuel diesel engine. The servicing module contains adequate suction hose to evacuate the two pillow tanks (or other fuel source) simultaneously and adequate delivery hose to fuel two aircraft simultaneously. The system is air transportable in a C-130 aircraft. Three modules complete with pillow tanks constitute an aircraft load. The number of R-14 units to be deployed to an installation is predicated on the number of aircraft to be supported. These units are sourced separately from Harvest Falcon assets and can vary in quantity from base to base. Additional 50,000-gallon bladders without the refueling module can also be deployed, normally in packages of four.

Figure 10.1. Fuel Servicing Module (R-14 Cart).



10.3.2. Storage Tanks. The system's two 50,000-gallon collapsible fuel storage tanks are made of rubber impregnated fabric. When unrolled, each tank measures approximately 28 feet wide by 68 feet long and when filled to capacity the tank height is 5 feet, 8 inches. Pillow tanks, like above ground steel tanks, require berms and liners to contain tank contents in case of rupture and to stop fragments and blast effects from near-miss explosions (figure 10.2). Collapsible tanks are actually less vulnerable than permanently installed steel tanks since they are close to the ground, have no vapor space, generate no sparks when penetrated, and have much lower static head.

10.3.3. Operations. Although the fuels management personnel from supply operate the refueling system, engineers are responsible for site preparation; building up and lining berms; unrolling the pillow tanks; connecting pipes, pumps, valves, and filters; and most maintenance.

10.4. Standardized Bare Base Laundry Facility. Field laundry service is part of the support that Services personnel provide at a bare base. Each laundry unit supports 550 persons. The laundry is normally operated by two individuals; a third person runs the linen and clothing pickup point. The facility is designed for 20 hours of sustained operations per day. At some bare base locations heavy duty household or commercial washers and dryers may be made available to personnel for self help laundry operations. The UNIMAC systems presently being purchased are illustrative of the machines being obtained for self-help laundry support. This system not only includes the machine itself, but also the heaters, hose, tentage, etc., necessary to allow the system to essentially stand alone. Such self-help operations do not significantly differ from peacetime stateside procedures, therefore, will not be addressed in this chapter.

Figure 10.2. Bermed Pillow Tanks.



10.4.1. Description. The laundry facility (figure 10.3) is air transportable and consists of an electrical panel, washer, extractor, dryer, air compressor, water pump, clothes bin, and M-80 water heater. Interconnecting cables, pipes, and hoses are included. All components are mounted on two platforms, which have removable 463L pallet locking rail assemblies. The laundry facilities are part of the housekeeping assets in Harvest Falcon and are also part of the Harvest Eagle package.

Figure 10.3. Standardized Bare Base Laundry Facility.



10.4.2. Site Preparation. The site selected for the laundry facility should be a relatively level area with adequate drainage. The laundry equipment requires approximately 75 square feet of space inside a general purpose medium or TEMPER tent which is erected by Services personnel.

10.4.3. Utilities. External power to operate the facility requires a power source capable of delivering 208-volt AC, 3-phase, 60-amp power. The water supply should be sized to provide up to 480 gallons per hour for 20 hours of sustained operations per day. Where water is scarce, the laundry's rinse water should be recycled as outlined in chapter 8. Making basic utility connections (electrical and water) to the unit is an engineer task. Services personnel are responsible for assembling the laundry unit to include setting up the heating unit, connecting all remaining hoses, joining the pallets together, and making electrical connections not associated with the power source.

10.5. Mobile Kitchen Trailer (MKT). The mobile kitchen trailer is an expandable, self-contained, trailer-mounted, field food service system designed to serve approximately 250 people per meal (figure 10.4). While the MKT is a Harvest Falcon mobile asset (industrial operations increment package), its primary use is as a training device at home station.

10.5.1. General Description. The system consists of standard field cooking equipment and is configured to allow efficient food preparation. The trailer platform is arranged into preparation counters, cooking areas, and a serving line. Environmental protection is provided by manually raised roof with fabric siding and insect screens. The MKT is mounted on a standard 1-1/2 ton M103A3 trailer chassis. It is towed by a standard 2-1/2 ton vehicle and is capable of traveling cross country over rough terrain. When set up for operation, the MKT is 11 feet high, 13 feet wide, and about 17 feet long. In a travel mode the dimensions are 8 by 8 by 14.5 feet. The total weight is 5,730 pounds. The MKT is intended primarily for use of "B" or "T" rations. Refrigeration is not provided with the MKT. However, perishable "A" rations can be used if refrigeration is available. The absence of a dining tent requires troops to eat outside the MKT.

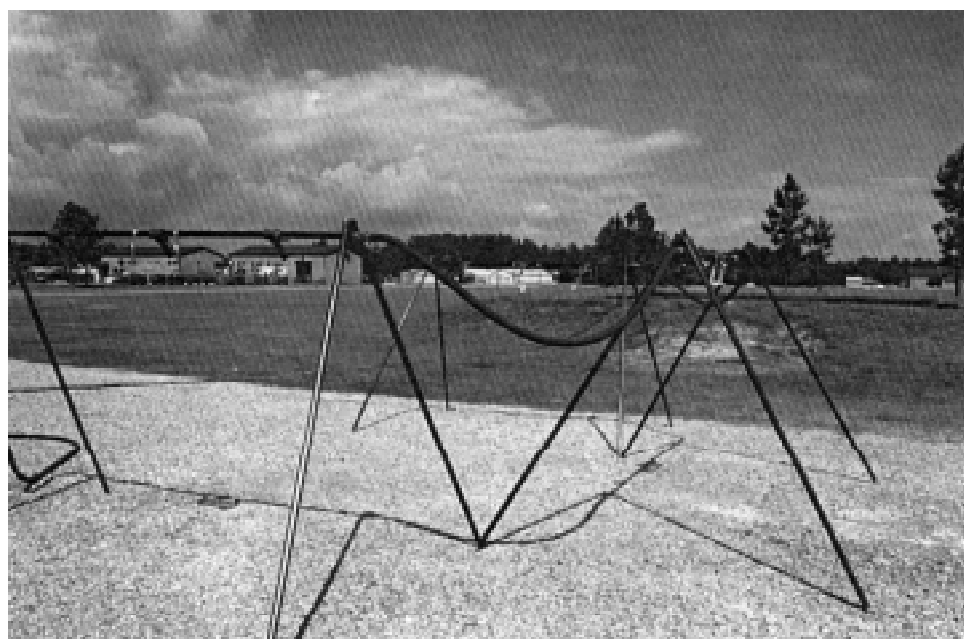
Figure 10.4. Mobile Kitchen Trailer (MKT).



10.6. Portable Bath Unit, 8-Shower Head. The M-1958 portable bath unit (figure 10.5) has been in the inventory for several years. Originally part of the Harvest Eagle package, it has been, for the most part, replaced by the Harvest Falcon shower unit.

10.6.1. Description. The M-1958 portable bath unit supplies warm water to each of the 8 shower heads through the use of a liquid fuel fired heating plant. The unit comes equipped with all the components necessary for the operation of the shower facility. Water is drawn through a suction strainer and hose from the water source. The 20-gallon heater raises and maintains the temperature at the desired level; the heated water is forced through the two discharge hoses to the shower stands by pressure from the incoming water. Energy is supplied through the use of a self-contained skid-mounted portable generator set. The portable generator set provides 3 kW, 60-cycle, 208-volt, 3-phase power. Grounding of all electrical components is accomplished through a fourth wire incorporated in the power cord cables which are connected to the generator outlet box. The outlet box is grounded to the generator frame which is grounded through a ground rod.

Figure 10.5. M-1958 Portable Bath Unit.



10.6.2. Site Selection. The ideal site for installation of the portable bath unit is beside a stream where wastewater can be carried downstream or downhill from the suction hose strainer. In this manner, wastewater will not be drawn back into the water source. If an ideal location is not available, then the bath unit may be set up in one of two alternative styles. First, you may be able to dig a ditch or build a dike around the shower stand which will allow the water to drain away from the water source. Or, if a pressurized water source is used, the water should be drained into an open reservoir in order to prevent undue strain to the water pump. Specifics on the installation, operation, maintenance and repair of the bath unit can be found in TM 10-4510-201-14.

10.7. Lightweight Decontamination System. The lightweight decontamination system (LDS) (figure 10.6) is a portable, gasoline engine driven pump and water heating unit. Its primary use is for decontamination of vehicles, equipment, and small areas such as facility entrances. The LDS weighs 330 pounds and measures 40 by 23 by 35 inches. The unit is designed to draw water from any source and deliver water and steam at controlled temperatures up to 248 degrees Fahrenheit at pressures up to 100 psi. The LDS includes a 145-pound accessory kit containing hoses, cleaning wands, and shower hardware. The unit's self-supporting bladder, made of rubberized fabric, weighs 70 pounds in its collapsed state and holds 1,580 gallons of water. Figure 10.6 shows the LDS in a trailer-mounted configuration with its water bladder positioned off to the side. A few different types of similar decontamination units exist in the inventory; however, they all work on basically the same operating principles. When using any decontamination system, extreme care must be taken to control and contain runoff to prevent spread of contaminants to other areas.

Figure 10.6. Lightweight Decontamination System.



10.8. Mobile Water Chiller. The skid-mounted, air-cooled, gasoline-driven water chiller (figure 10.7) is designed for continuous operation in a high temperature environment typical of the desert and tropical regions where bare bases may be located. The water chiller is designed for cooling treated water contained in storage tanks or water trailers. The water chiller is capable of cooling intake water of 120 degrees Fahrenheit to 60 degrees Fahrenheit at a delivery rate of approximately 40 gph. When water is not dispensed for immediate use, the chiller will recirculate water to maintain low temperature. As mentioned in previous chapters, the chiller will be used predominantly in a water trailer-mounted mode (figure 10.8) at various points of use on the bare base.

10.9. M-80 Heater. The M-80 heater (figure 10.9) is the primary boiler component for several bare base assets, namely, the M-1958 bath unit, the Harvest Falcon shave/shower unit, the Harvest Falcon kitchen, and the bare base laundry. The heater is self-contained and operates on either diesel fuel or gasoline consuming about five gallons per hour. It weighs approximately 465 pounds and is skid-mounted with forklift inserts for ease of movement. Its overall size is 52 inches long by 27 inches

wide by 47 inches high. The heater comes as an integral part of all the systems it supports, i.e., it does not have to be requested separately. Details on the operation of the M-80 water heater can be found in TM 10-4510-206-14.

10.10. Preway 70,000 BTU Tent Heater. The Preway tent heater (figure 10.10) can be used with either the general purpose type tents or the TEMPER tents found in the Harvest Eagle and Falcon sets. The relative ease of assembly and operation of this heater make it an optimum device for use in temperate climates. Assembly of the unit is accomplished by engineer personnel and operation of the unit is a users responsibility. Be prepared, however, to provide instruction to the base populace on heater operation.

10.10.1. Description and Installation. The Preway radiant type heater operates on diesel fuel only; use of any other type of fuel can result in detonation of the heater. Fuel is stored and fed from a standard 5-gallon Jerry can hung on the left side of the heater frame. Designed for floor installation, the heater must be installed in a well ventilated area and rest on non-combustible material. Stove pipe sections run from the heater through the roof of the tent. The stove pipe sections must be at least 18 inches from combustible materials unless shielded by metal or other approved material. It is particularly important to ensure the heater is level both from the front to rear and side to side directions. This permits the flow of oil to the heater to remain steady. The heater weighs approximately 205 pounds with dimensions (without stove pipe) of 33 inches long by 30 inches wide by 41 inches high. Several models of this type of heater are in use; therefore, weights and dimensions may vary slightly. See TM 5-4520-235-13 for operational details.

Figure 10.7. Water Chiller.



Figure 10.8. Trailer-Mounted Water Chiller.

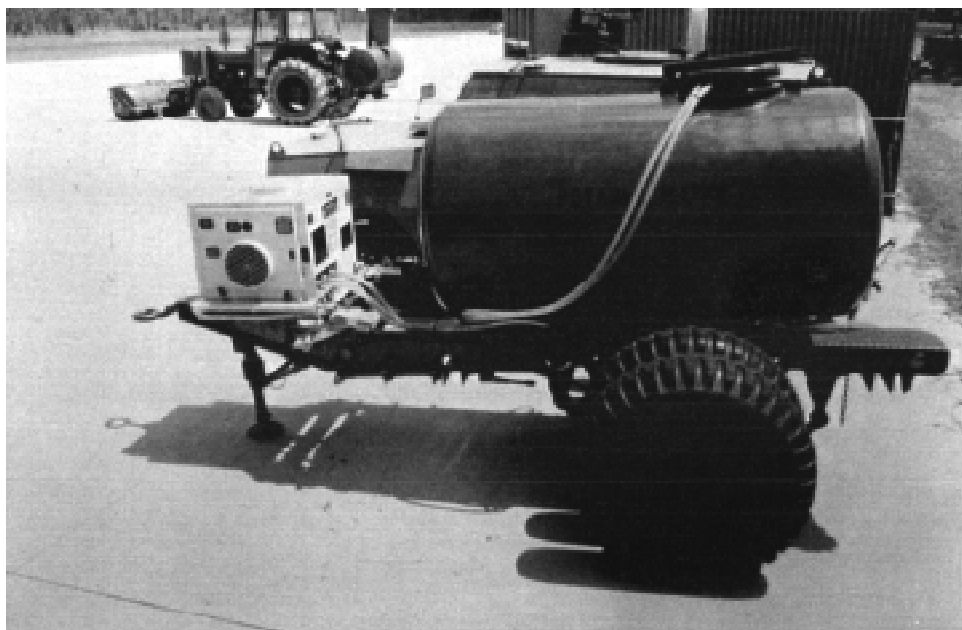


Figure 10.9. M-80 Water Heater.

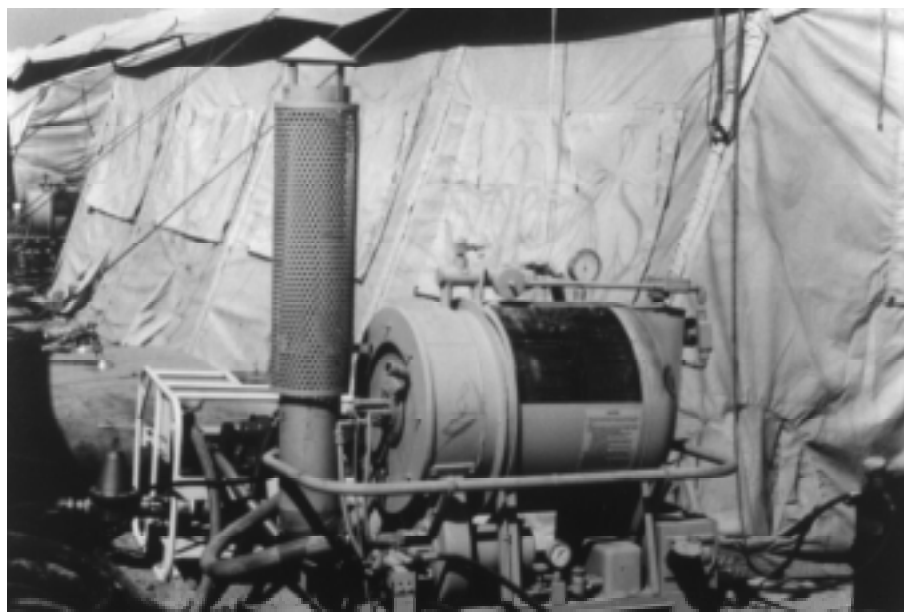
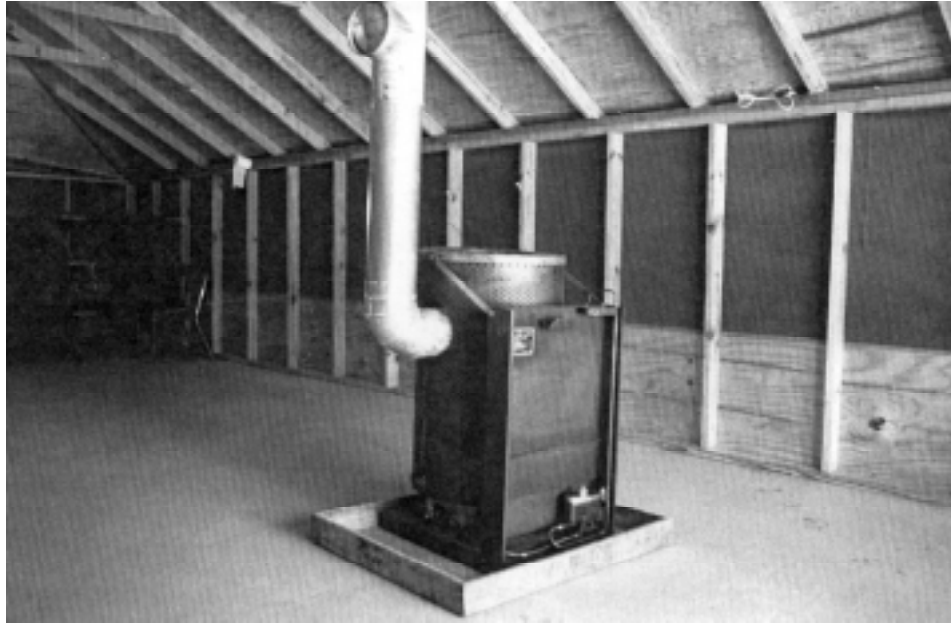


Figure 10.10. Preway 70,000 BTU Heater.

10.11. M-1941 35,000 BTU Tent Heater. The basic M-1941 heater is a solid fuel device similar to the old-time pot-bellied stove. A conversion kit exists which alters the solid fuel heater to a liquid fuel version. These liquid fueled heaters are found in Harvest Eagle sets (figure 10.11). They can burn diesel fuel, light fuel oil, or gasoline although at different fuel consumption rates (gasoline is used quickest). Regardless of fuel used, however, refueling will have to take place daily if 5-gallon Jerry cans are used. Designed for floor installation, M-1941 heaters should be set upon a non-combustible surface and no combustible materials should be placed within four feet of the units. Like the Preway heaters, M-1941 heaters are vented through tent roofs using standard stove pipe material. The M-1941 heater weighs approximately 75 pounds and requires a floor area of about 28 inches by 40 inches. With proper training, user personnel can operate these units once they have been installed by engineers. Details on the operation of the M-1941 heaters, both solid and liquid fuel versions, can be found in TM 10-4500-200-13.

10.12. Environmental Control Unit (ECU). The A/E32C-39 air conditioner is intended for use in heating and cooling, dehumidifying, filtering and circulating air in portable shelters and vans to meet the controlled environmental requirements of personnel and electronic equipment (figure 10.12). A means is provided for admitting fresh air at a controlled rate. In a typical application, the air conditioner is located external to the controlled space (normally about 6 feet away) and conditioned air is circulated into the controlled space through supply and return ducts. ECUs are included in all four Harvest Falcon asset deployment echelons in sufficient numbers to support the facilities included in each echelon.

10.12.1. Description. The ECU is completely contained in a unitary enclosure. Power turn-on and temperature selectors are accessible at an external control panel. Refrigeration is produced by an electric motor-driven compressor, a condenser, an evaporator, and associated controls. An electric fan for condenser cooling and a centrifugal blower for conditioned air distribution are integral with the unit. Heating is provided by six electrically operated tubular heating elements. Space is provided for storage of flexible ducts to be attached to the conditioned air delivery outlet and return inlet.

10.12.2. Engineering Particulars. The ECU operates on the conventional vapor-compression-cycle principle. Heating, cooling, and dehumidifying are thermostatically controlled. The nominal cooling capacity is 4-1/2 tons. The heating capacity is 9.6 kilowatts. The overall dimensions of the unit are 71 inches long, 48 inches wide, and 32 inches high. Refrigerant used is R-22 with a refrigerant capacity of 10 pounds. The unit weighs approximately 920 pounds and forklift slots are an integral part of the unit's container. See TO-5-4120-390-14 for further details.

10.12.3. Future Enhancements. A replacement for the existing A/E32C-39 unit is under development. Initial tests have indicated this replacement unit is 25% more efficient and can operate effectively at higher ambient temperatures as compared to the current ECU. It also uses "ozone friendly" R-134A refrigerant. Perhaps of most importance from a mobility aspect however, is that the new unit is smaller and lighter than the existing unit. These weight and cube improvements have doubled the number of ECUs that can be packaged per pallet.

Figure 10.11. M-1941 Heater.

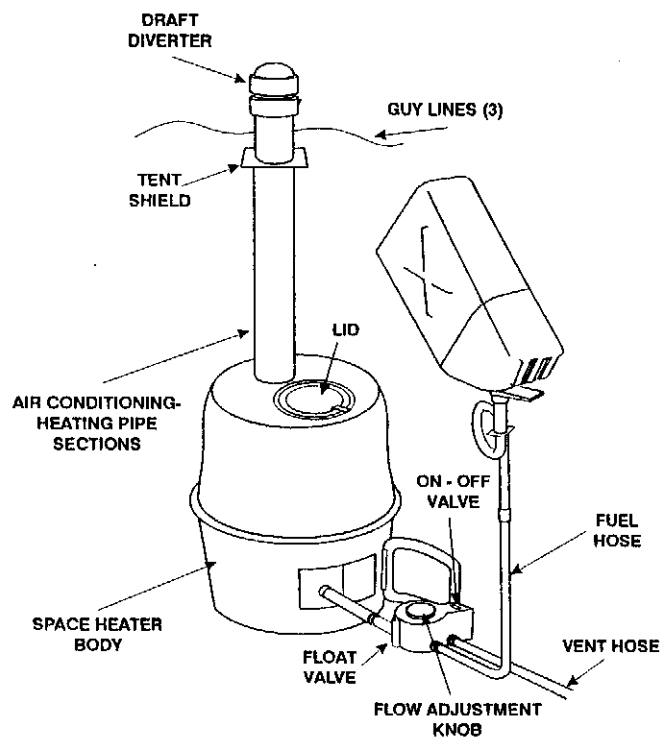
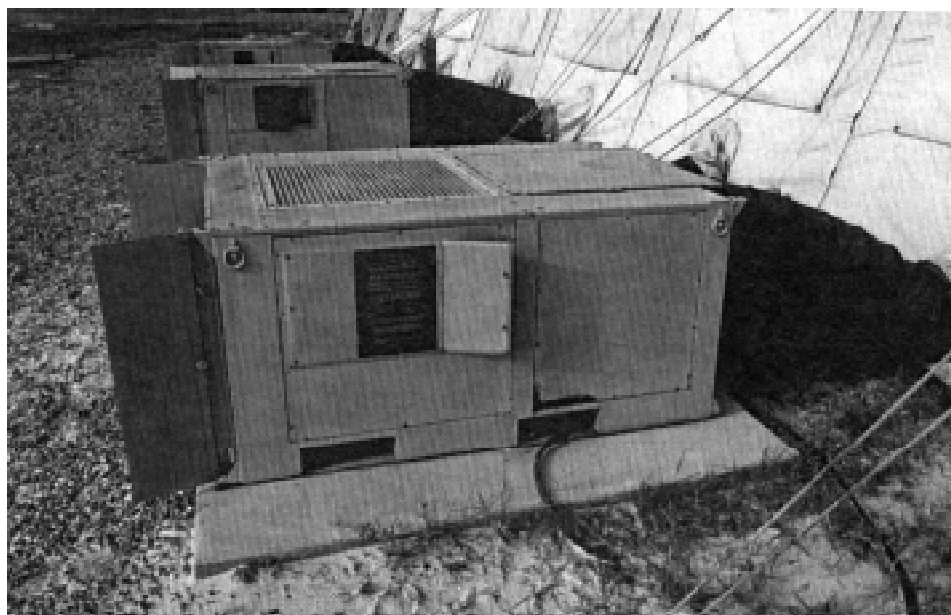


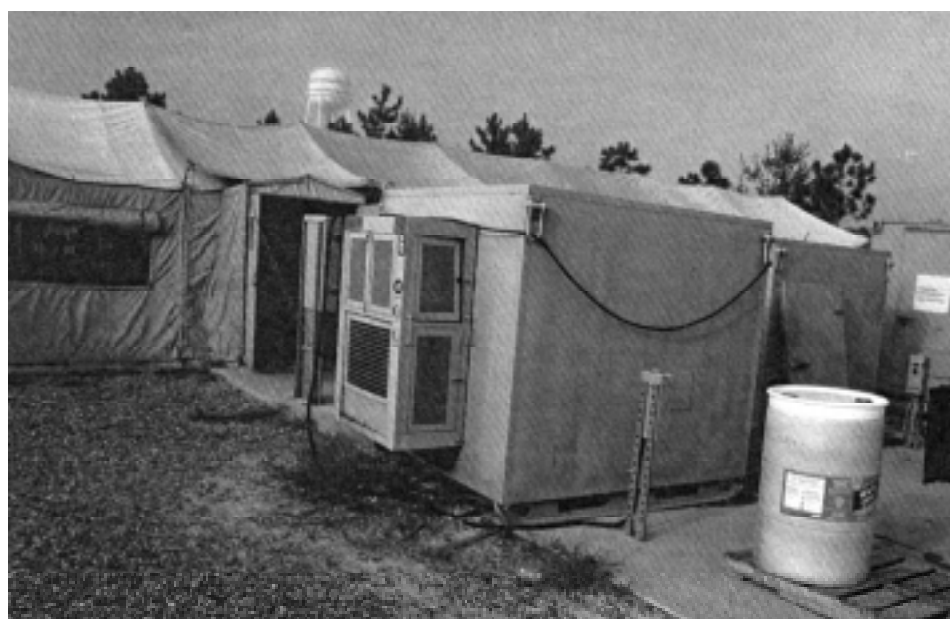
Figure 10.12. A/E32C-39 Environmental Control Unit.



10.13. Walk-In Refrigeration Units. Both the Harvest Eagle and Harvest Falcon systems contain portable walk-in refrigeration units which support food service operations at the 9-1 kitchens. Harvest Eagle contains smaller 150 cubic foot units, whereas Harvest Falcon contains both 150 and 1,200 cubic foot units. Engineers are responsible for the set up, operation and maintenance of these units. Under non-wartime conditions, an individual must be universal chlorofluorocarbon (CFC) qualified in order to purchase, dispose and recover refrigerant. The units come in two sections -- an insulated box and a mechanical refrigeration package.

10.13.1. Refrigeration Boxes. The refrigeration boxes are secure, insulated containers in which the mechanical refrigeration equipment can be installed (figure 10.13). The boxes can be moved by forklift utilizing the forklift holes provided in the aluminum skid which is a permanent part of the boxes. Lifting loops are also provided on each corner near the top so that the boxes can be lifted by crane, boom, or helicopter. The walls, floor, and ceiling of the boxes are aluminum-framed, filled with densely-packed insulating foam, and covered with sheet metal. The boxes must be placed on a smooth, level surface to allow ventilation under the floor and ensure proper fitting and closing of the door.

Figure 10.13. 150 CF Walk-In Refrigeration Unit.



10.13.2. Mechanical Refrigeration Units. The main components of the mechanical refrigeration packages include a condenser, compressor, and evaporator. The units maintain the temperature of the boxes between 0 and 35 degrees Fahrenheit and use R-12 as the refrigerant. Newer units being procured are R-134 compatible. The unit supporting the 150 cf box is rated at 5,000 BTUs and requires 220-volt, 3-phase electrical power. The unit associated with the 1,200 cf box is rated at 10,000 BTUs and requires 208-volt, 3-phase power. With the assistance of a forklift, the mechanical units can be installed by two people.

Chapter 11

MEDICAL FACILITIES



11.1. Introduction. All medical resources are of vital importance to wartime operations. Deployment of medical treatment facilities (MTF) is necessary to support and sustain sortie generation at the bare base; the basic premise is treat and return to duty when possible, or evacuate and replace. Using the Stages of Care medical concept, the Air Force has developed multiple deployable MTFs to treat and/or evacuate casualties under all conditions.

11.2. Overview. This chapter begins with a discussion of the four Stages of Care in a theater of operation. Stages of care are defined in time rather than capability and/or size of the medical facility. This is followed by an outline of civil engineer responsibilities for the support of bare base medical facilities. Each type of medical treatment facility is described in detail to permit bare base planners to gain an appreciation of the magnitude of the engineer task involved. Facility layouts are also shown. Finally, engineer support requirements are summarized in tabular format for use as a ready reference in the planning process.

11.3. Concept of Operation.

11.3.1. Echelons of Medical Care.

11.3.1.1. Stage I. Stage I care is defined as medical treatment beginning within one hour of injury/illness. If medical care is not available within one hour, it should be provided by the casualty (self-aid), or a fellow airman (buddy) through first aid kits, shelter first aid kits, chemical agent antidotes, and any improvised material readily at hand. If required by the situation, the bare base commander may establish casualty collection points (CCP) to consolidate casualty management and to serve as a transition point between large numbers of casualties and the nearest MTF. Individuals requiring medical care must normally reach the CCP (or nearest MTF) by themselves or with the assistance of their buddies (using transportation organic to the unit). Medical personnel will then provide transportation from the CCP to the MTF; otherwise transportation must be provided through the survival recovery center (SRC).

11.3.1.2. Stage II. Stage II is professional medical care initiated within two hours of injury/illness. It will consist of all capabilities from the previous Stage I with additional services being provided: emergency room, sick-call, limited surgical capability, in-patient holding, public health, preventive medicine, pharmacy, laboratory, x-ray, aeromedical evacuation and others. Examples of MTFs that might be found at this location are Air Transportable Clinics (ATC) and Air Transportable Hospitals (ATH) or its components.

11.3.1.3. Stage III. Stage III is professional medical care initiated within six hours of injury/illness. This expanded level of care is characterized by those capabilities from the previous Stage II plus the following additions/expansions: emergency

room, primary care and sick-call, specialized surgical capability, in-patient holding, public health, preventive medicine, pharmacy, laboratory, x-ray, aeromedical evacuation, medical administration, mental health, medical sub-specialties, and others.

11.3.1.4. Stage IV. Stage IV is professional medical care initiated within 6-14 days. It encompasses all capabilities from the previous stages with additions of rehabilitation, advanced diagnostic procedures, multiple specialists, etc.

11.3.2. Deployment Sequence.

11.3.2.1. Air Transportable Clinic. Normally, initial bare base medical support will be furnished by an ATC which must be operational within 24 hours of arrival. It may be augmented or preceded by a preventive medicine team (2-6 persons). This team will normally co-locate with the first MTF to arrive.

11.3.2.2. Air Transportable Hospital. The 50-bed ATH will normally be deployed in increments beginning with a 10-bed ATH segment called Coronet Bandage, increasing to a 25-bed intermediate ATH, and finally reaching full capability as a 50-bed ATH with the arrival of the third increment. Each increment of the ATH must attain operational capability within 24 hours of arrival at the bare base.

11.3.2.3. Contingency Hospital (CH). The 250-bed CH is expected to be operational within 10 days of arrival.

11.3.2.4. Aeromedical Staging Facility (ASF). The ASFs designed for SWA are deployed in increments. The initial increment is termed Coronet Early Return. The ASF can achieve operational status within 24 to 72 hours.

11.3.2.5. Transportable Blood Transshipment Center (TBTC). The TBTC will normally be located at or near a strategic airhead. It is, however, mobile and does require base support.

11.4. Civil Engineer Support of Medical Facilities. In general, Air Force medical doctrine restricts staff capabilities to those actions that directly perform and support medically specific functions and technology associated with a medical unit's mission. For all other functions, the medical facility must rely exclusively upon those combat support elements to whom the medical support is provided. In a bare base environment, this support responsibility translates into the following engineer tasks:

11.4.1. Site Preparation - must meet the medical facility's specific layout requirements.

11.4.2. Shelter Erection - furnishing technical direction for shelter erection and, when required, augmenting medical personnel for the assembly of discrete, functional modules into an operating hospital complex. A 10-15,000 lb all-terrain forklift must be available to set up the ATH, CH, MASF, or ASF.

11.4.3. Utilities - providing water and electricity, disposal of liquids, solid and biological wastes, final connection of bare base utility systems to the medical facility's utility interfaces, and providing heat, ventilation, and air conditioning support to maintain specified temperatures.

11.4.4. Operation and Maintenance - includes war damage repair of the physical plant, utility systems, and installed, non-medical equipment.

11.4.5. Fire Protection - establishment of a response posture to meet the fire protection requirement for the type of medical facility being supported (for determination of additive vehicles and personnel, see attachment 21).

11.4.6. EOD - providing instructions and procedures on how to conduct medical postattack and recovery operations in an UXO environment.

11.5. Support Requirement by Type of Facility.

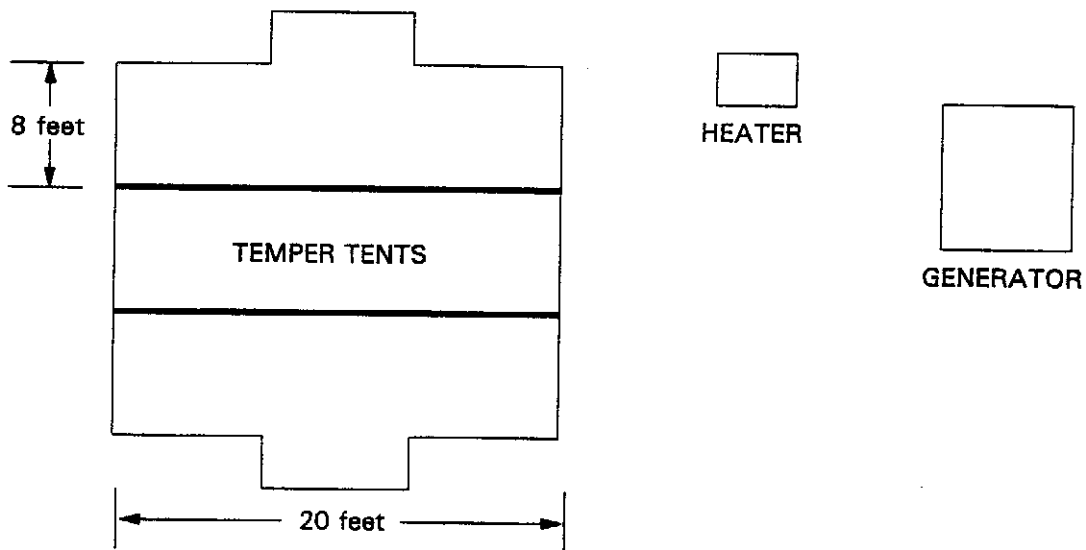
11.5.1. Air Transportable Clinic. The ATC provides limited outpatient clinic and short-term care. Advanced cardiac life support, limited laboratory, and limited patient-holding capability may be available. Normally the ATC is collocated with other medical facilities. Staffing consists of one physician and three medical technicians. These personnel, the squadron medical element, appear on the mobility roster of the flying squadron they support.

11.5.1.1. Casualty Rate and Patient Capacity. The ATC performs outpatient clinic services for approximately 600 personnel and may have a limit patient-holding capacity (six cots). For extended bare base operations when a deployed squadron is serviced only by an ATC, a 4-person squadron medical element augmentation team is sometimes provided to enhance capabilities in the areas of food safety; field hygiene and sanitation; nuclear, biological and chemical detection; vector surveillance; and communicable disease control.

11.5.1.2. Facility Shelters, Components, and Equipment. The ATC may be housed in three 8 foot by 20 foot TEMPER tent sections (figure 11.1), or on General Purpose Medium (GPM) tent. The equipment set includes: Hunter 60,000-BTU heater, interior lights and electrical outlets, refrigerator, cardiac monitor, portable autoclave, and possibly one ambulance.

11.5.1.3. Site Requirements. Approximately 1,500 square feet of clear ground is required. The site should not have more than an 18-inch drop in 20 feet.

11.5.1.4. Organic Shelter Erection Capability. The number of personnel assigned to the ATC is insufficient to erect the TEMPER tents. Assistance must be provided by either the flying squadron or civil engineers.

Figure 11.1. Air Transportable Clinic Layout.

11.5.1.5. External Support Requirements. Table 11.1 summarizes civil engineer support requirements. No significant additives are required for the provision of water, ice and waste disposal.

Table 11.1. Support Required for ATC.	
ITEM	SUPPORT
Site Preparation	1,500 SF
Billeting, Latrines, Food Service, etc.	4 people
Power	10-15 kW
Fuel	
Diesel (15-kW generator)	60 gal/day
MOGAS	30-35 gal/day

11.5.2. Air Transportable Hospital. The 50-bed ATH provides triage, casualty handling, resuscitative surgery, stabilization, medical and dental care, preparation for evacuation of casualties, and a limited capability to treat chemical warfare contaminated patients. The ATH is staffed by 128 personnel.

11.5.2.1. Facility Shelters. The ATH utilizes 70 TEMPER tent sections and three International Standardization Organization (ISO) shelters. All medical functions are housed in TEMPER tents, except for surgery, x-ray, and laboratory. The latter functions use ISO shelters (a 15,000 lb all-terrain forklift will be required to move these containers). Since the ATH is designed in a modular or incremental fashion, a quick response sub-set can be transported in one or two C-141 aircraft. The initial increment of the 50-bed ATH is termed Coronet Bandage. Coronet Bandage can handle limited acute trauma and minor surgery while awaiting arrival of aeromedical evacuation, the remainder of the ATH, or both. Initial supplies deployed with Coronet Bandage permit 30 days of operation, depending upon the number and types of casualties encountered. The Coronet Bandage has 10 beds to provide minimal inpatient care. The remainder of the ATH is palletized so that a second increment can be deployed and erected onto the first increment. When this intermediate increment is in place, the ATH has 25 beds, provides full surgical stabilization, and has supplies for 30 days. The final ATH increment deploys a 25-bed ward and the remainder of the personnel and supplies. Some ATHs destined for SWA deployment are designed to operate for 60

days without resupply support (medications, medical equipment and supplies to perform medical operations). For peacetime training exercises only the Coronet Bandage or 25-bed Intermediate ATH will be deployed.

11.5.2.2. Components and Equipment. The ATH deploys with tools needed for erection, two MEP-7 portable 100-kW generators (for initial and backup power), a 400-gallon water trailer, and heating (H80) and air conditioning units (C100). PVC pipes, hoses and clamps permit utility connection to the bare base water distribution and liquid waste disposal systems.

11.5.2.3. Site Requirements. Approximately 50,000 square feet (230 feet by 230 feet) of clear ground is required. The site should not have more than an 18-inch drop in 20 feet. The ATH should be sited in low threat areas, but near support group services (showers, billeting, kitchen). Site grades must slope away from the shelter to prevent flooding. Figure 11.2 contains the current design for the 50-bed ATH.

11.5.2.4. External Support Requirements. The ATH is equipped and staffed to provide medical support only; therefore, the facility is dependent upon base support as indicated in Table 11.2.

Figure 11.2. 50-Bed ATH.

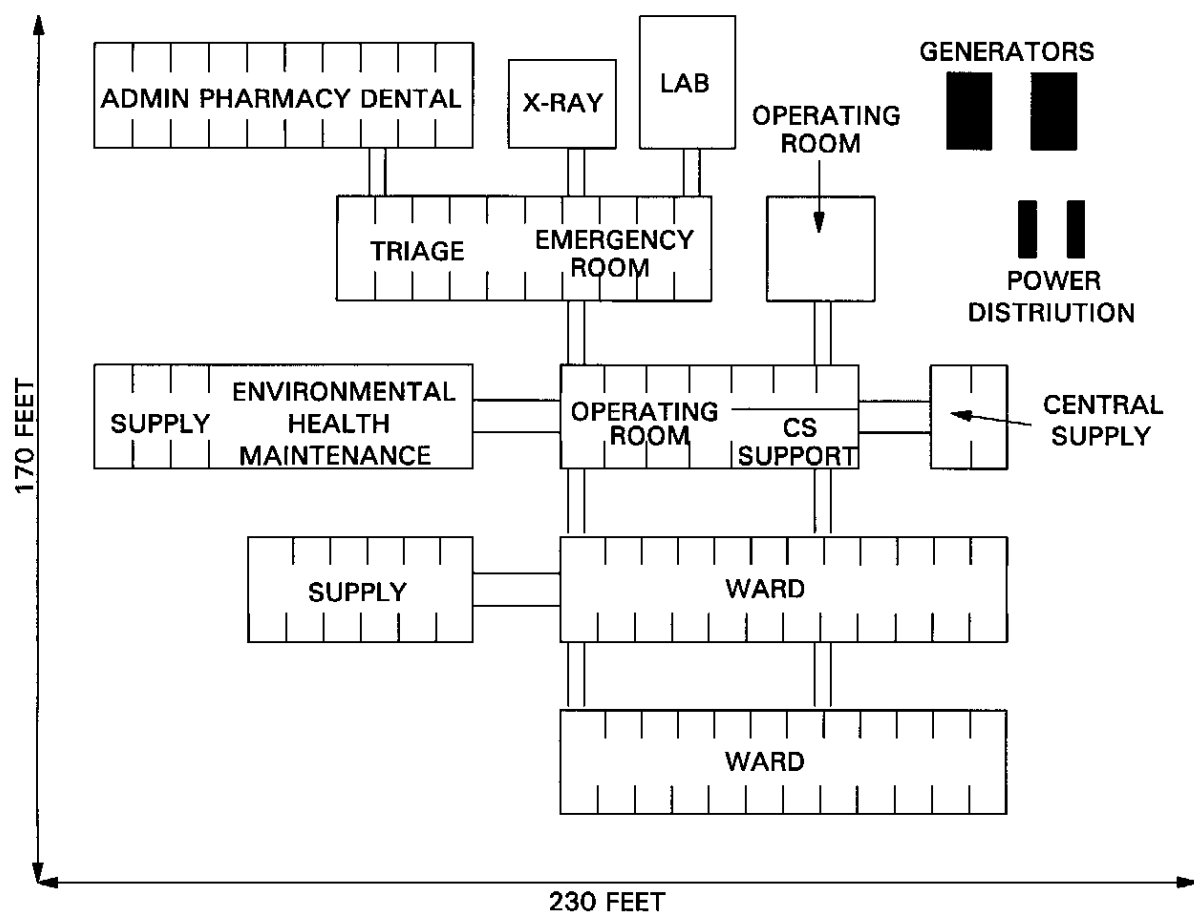
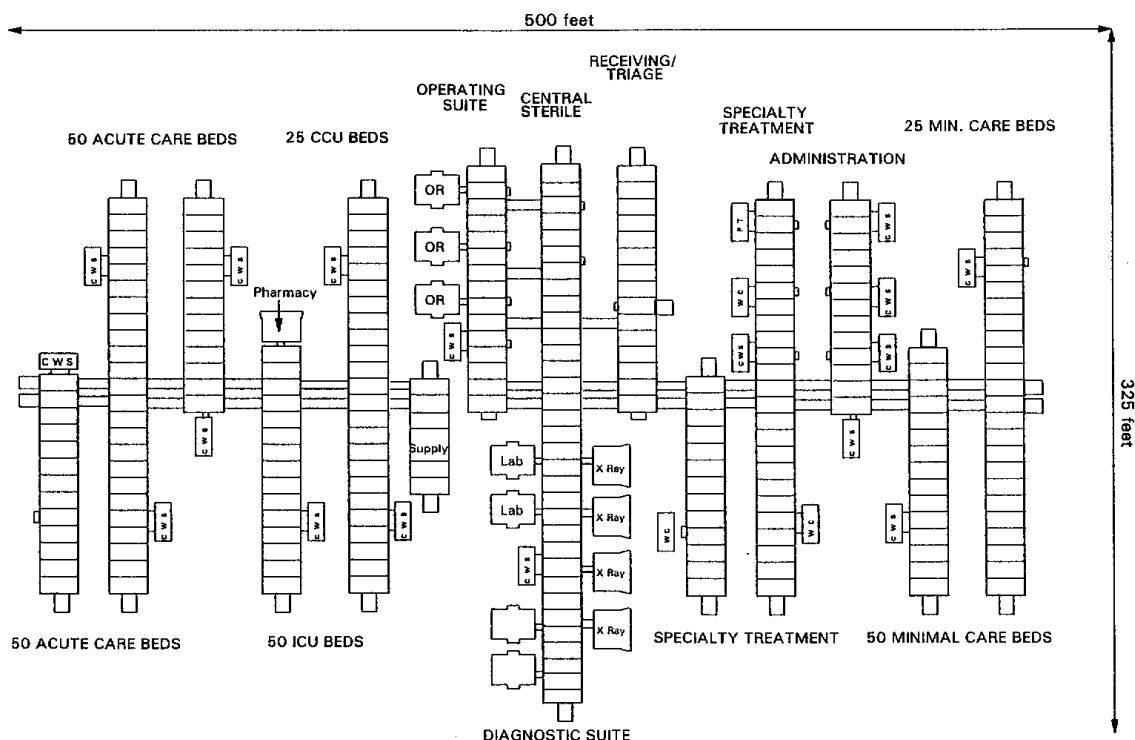


Table 11.2. Support Required for ATH.			
ITEM	CORONET BANDAGE	25-BED ATH	50-BED ATH
Site Preparation	26,000 ft ²	40,000 ft ²	50,000 ft ²
Billeting	43 people	96 people	128 people
Latrine/Showers*	57 people	121 people	178 people
Food Service			
Regular	141 meals/day	285 meals/day	453 meals/day
Liquid	4 meals/day	8 meals/day	12 meals/day
Laundry	3,000 lb/week	6,000 lb/week	9,000 lb/week
Power	92 kW	170 kW	200 kW
Fuel			
Diesel	300 gal/day	600 gal/day	600 gal/day
MOGAS	60 gal/day	90 gal/day	120 gal/day
Water	2,000 gal/day	3,500 gal/day	5,500 gal/day
Ice	85 lb/day	150 lb/day	300 lb/day
Waste Disposal			
Liquid	1,800 gal/day	3,150 gal/day	4,950 gal/day
Solid	6,000 lb/day	11,600 lb/day	18,500 lb/day
*Staff and patients.			

11.5.3. Contingency Hospital. The 250-bed CH is a field medical assemblage designed to provide Stage I-Stage III care. It is equipped to furnish definitive medical, dental and surgical care for patients who are expected to return to duty within 15 days, and also to provide stabilization for further evacuation for patients who will not return to duty within the theater. Designed in modular fashion, the CH can be deployed incrementally. The initial sub-set provides limited acute trauma life support and minor surgery capability pending arrival of either aeromedical evacuation, the remainder of the 250-bed CH, or the collocation of an ATH. When the entire CH is in place (erected onto the first increment), it can operate for 60 days without resupply (except blood) depending upon the type of casualties treated. The CH facility layout is shown in figure 11.3.

Figure 11.3. Facility Layout - 250-Bed Contingency Hospital.



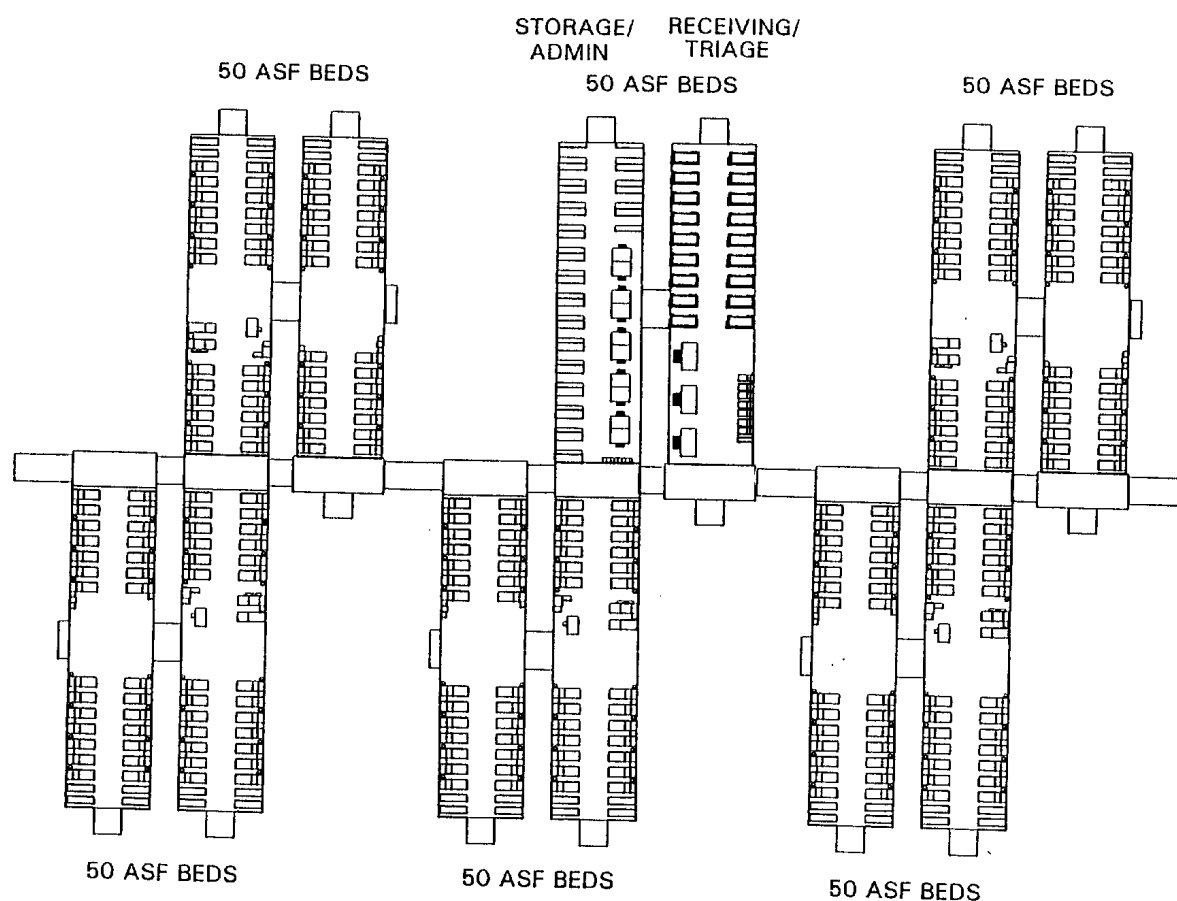
11.5.3.1. Facility Shelters, Components, and Equipment. The CH uses 250 TEMPER tent sections, 31 ISO shelters, and the 9-1 kitchen. A medical logistics warehouse is also on or near the CH complex. Tools needed for erection and portable 100-kW generators (for initial and backup power) are deployed with the CH. Six ambulances and three ambuses provide transportation for patients.

11.5.3.2. Site Requirements. The 250-bed CH can be erected on moderately uneven terrain away from trees and valleys (no more than 18 inches drop in 20 feet). It requires approximately 28 acres (44 acres if helipad access is available). Site grades must slope away from shelters to prevent flooding. Core wings should differ in elevation from adjacent wings by no more than two feet. The CH must be sited near a base support complex.

11.5.3.3. External Support Requirements. Since the CH is equipped and staffed to provide medical support only, the facility is dependent upon the base for support as indicated in table 11.3.

Table 11.3. Support Required for CH.	
ITEM	SUPPORT
Site Preparation	
Without Helipad	28 acres
With Helipad	44 acres
Billeting, Latrines and Showers	588 medical staff
Food Service*	515 meals/day
Laundry	36,000 lb/week
Power	1,300 kW
Fuel (Diesel)	
Initial Deployment	900 gal
Normal Operations	4,000 gal/day
MOGAS	180 gal/day
Water	22,000 gal/day
Ice (5 lbs/bed/day)	1,250 lb/day
Waste Disposal	
Liquid	35,000 gal/day
Solid	25,000 lb/day
*Medical Staff Only	

11.5.4. Aeromedical Staging Facility. An ASF is the aeromedical evacuation interface between the evacuation system and the MTF (i.e. ATH, CH) where the injured/ill personnel have been treated. The ASF is staffed by approximately 135 personnel. The ASF can be erected into a fully operational status within 24 to 72 hours in most climates. It is designed in a modular fashion and deployed in increments. The initial increment is termed Coronet Early Return, and is capable of operating in this mode for 7 to 14 days (depending on casualty load). When the remaining increments are in place, the ASF has up to 250 beds, 4 ambuses and supplies for 60 days of operation (figure 11.4).

Figure 11.4. Facility Layout - 250-Bed ASF.

11.5.4.1. Casualty Rate and Patient Capacity. Under normal conditions the ASF is capable of receiving 250 casualties in a 24-hour period. Normally, casualties will be evacuated within 24 hours after entry into the ASF.

11.5.4.2. Facility Shelters, Components and Equipment. The ASF uses 168 TEMPER tent sections. Tools needed for erection, portable 100-kW generators (for initial and backup power), and environmental control systems are deployed with the ASF increments.

11.5.4.3. Site Requirements. Approximately 90,000 square feet of clear and level ground are required. The site should not have more than an 18-inch drop in 20 feet. The ASF must be sited near a base or support complex.

11.5.4.4. External Support Requirements. Table 11.4 indicates base support required by the ASF.

Table 11.4. Support Required for ASF.	
ITEM	SUPPORT
Site Preparation	90,000 ft ²
Billeting, Latrines and Showers	135 medical staff/100 ambulatory patients
Food Service	114 meals/day
Laundry	16,920 lb/week
Power	200 kW
Fuel (Diesel)	500 gal/day
Water	12,000 gal/day
Ice	1,250 lb/day
Waste Disposal	
Liquid (.70)	8,400 gal/day
Solid	12,000 lb/day

Chapter 12

SITE SPECIFIC PLANNING



12.1 Introduction. The guidelines and planning factors presented in preceding chapters were mostly generic in nature and when directed at a particular geographic application, such as Southwest Asia, these special considerations were prompted by the worst case conditions imposed by a desert environment. While an arid climate undoubtedly presents the bare base planner with a myriad of problems not likely to be found elsewhere, there may well be situations in other regions of the world where the unique characteristics of a bare base site and other factors combine to impose problems of a similar magnitude. In preparing a comprehensive bare base development plan, nothing should be taken for granted. Consider the common plight of military engineers in two vastly different regions of the world. During an exercise deployment to SWA, Air Force engineers disembarked at a desert air base to find that the only drinkable water immediately available was that carried in their canteens. Army engineers deployed to a Central American airfield construction site faced a similar problem: on arrival in what had been expected to be a lush, tropical environment with an abundance of water, the Army engineers were confronted by a barren area engulfed in layers of dust - a common situation during the dry season, even in the tropics. Obviously, the information generally available about a given deployment area and bare base site should not be taken at face value; it must be supplemented with up-to-date planning data that takes into account specific characteristics such as airfield configuration, topography, climate, existing facilities, and similar factors.

12.2. Overview. The focus of this chapter is on structuring the essence of previously presented information into a format that permits the bare base planner and engineer to use a step-by-step approach toward the development of a comprehensive base development plan. The essential requirements for such a plan are covered in detail. General and specific planning considerations which are dictated by the climatic and topographic characteristics of a given area serve as a checklist to ensure, to the extent possible, that the planner identifies the questions which need to be answered about a specific bare base site. Bear in mind that the planning considerations provided are not solely linked to the use of Harvest Falcon or Harvest Eagle assets, but rather are meant to address situations where no specific facility packages are identified. The intent is to give the planner and engineer advice, normally gleaned from experience, that is applicable to specific regional areas.

12.3. Data Collection. The importance of effective data collection was mentioned briefly in chapter 2. This section provides more definition to the process and suggests sources that may be tapped for current information.

12.3.1. Mission Analysis. As with any military task, a thorough analysis of the mission is the keystone to effective bare base planning. What will be the primary mission of the bare base? Will the base support fighter, fighter-bomber, reconnaissance or a combination of these weapon systems? Will the bare base serve as an aerial port supporting tactical airlift, C-130s and C-141s, or strategic airlift involving C-5s, C-141s and commercial wide-body transports? The answers to these questions will

drive all subsequent planning steps. Equally important to your mission analysis is finding out what level of aircraft maintenance is planned at the base. The number of aircraft and level of maintenance are key determinants of the number and type of operational support facilities. Another mission data item of vital interest to the bare base planner is the size of the population required to support the aircraft to be deployed. When operational commands plan to deploy with their organic combat support elements, the size of the bare base population can be established in precise numbers. When such is not the case, use the matrix of aircraft mix versus assumed population levels (table 4.1, chapter 4) as a starting point to calculate and refine the population required to support the projected mission for the base under consideration. Once the mission has been analyzed and you have arrived at an initial estimate of the expected base population, the next logical step should lead you to an analysis of the threat.

12.3.2. Threat Analysis. Your threat analysis will determine whether facilities and utility plants will be dispersed or centrally located, whether revetments and rapid runway repair sets will be required, and will indicate the level of effort to be expended on defensive fighting positions and camouflage, concealment and deception measures. It could also indicate the degree of conveying, resource dispersal, and work party security activities that might be necessary, all of which normally translate into longer construction times. The prudent planner will also make allowance for the potential of chemical weapons being used against the bare base by, as a minimum, identifying the additional resources needed to provide the base with a decontamination capability.

12.3.2.1. In World War II, the vulnerability of a theater air base was largely determined by its proximity to the forward edge of the battle area. Since the Vietnam conflict, the distinction between forward and rear areas has become blurred and the prediction of a base's vulnerability has become more difficult to make. Consequently, the air threat against a particular bare base must be officially assessed and defined through Air Force intelligence channels. Ground threats are assessed by both Intelligence and the Office of Special Investigation (OSI).

12.3.3. Site Specific Data Analysis. This analysis involves gathering as much data as possible about a bare base location and then using it as a guide during the actual planning and layout of the bare base. Typical data to be collected include basic terrain features, weather and climatic factors from maps, atlases, aerial photos, drawings, layouts, climatic records, and any other similar sources of data. Additionally, any information on existing facilities, utilities and pavements should be obtained. Furthermore, any information on supporting resources such as indigenous labor and contractor availability, assured host nation support, and supply and construction material sources should be gathered. Once all reasonably available data have been obtained, they must be studied and combined to predict their influence on site layout, installation of facilities, utilities, camouflage, and defense positions; and the operation and maintenance of the base.

12.3.3.1. Site Visit. If such an advance visit is possible, capable individuals should be dispatched to contact their local counterparts, if any, and to investigate those aspects of existing facilities and available resources that relate to their job. For example, send a qualified engineer to assess airfield pavement capabilities, power and water specialists to learn the local systems, engineer technicians to obtain or make base layout drawings, and supply personnel to investigate supply procedures and materials at hand (a checklist recommended for use during a site visit is shown in attachment 16). The senior engineer person should personally contact the host base engineer (or equivalent) to discuss engineer missions, operational procedures and mutual support.

12.3.3.2. Sources of Information. If a site visit and ground reconnaissance are not feasible, a considerable amount of essential data can be gathered from the sources listed below:

12.3.3.2.1. Flight Information Pamphlets. Carried by aircrews, these publications give nominal runway lengths and load capacities and are normally available at base operations.

12.3.3.2.2. Airfields Database. The Defense Mapping Agency (DMA) maintains a database containing information on every airfield in the world. The database provides information on airfield pavements, utilities, facilities, fuel, and off-base support. Database extracts are available from MAJCOMs through the Worldwide Military Command and Control Systems (WWMCCS) or its replacement, the Global Command and Control System (GCCS).

12.3.3.2.3. Pavement Evaluation Reports. Pavement data for many allied bases worldwide have been compiled in these reports by HQ AFCEA. Contact:

HQ AFCEA/CESC
Tyndall AFB, FL. 32403
(DSN 523-6330)

12.3.3.2.4. Air Navigation Charts (ANC). ANCs provide detailed information for airfields longer than 4,000 feet for all countries in the world. Published by the Defense Mapping Agency (DMA), these charts are described in the DMA catalog which should be available at base operations. If map requirements (base names/locations) are identified to base operations personnel, they can order these products for you from DMA.

12.3.3.2.5. Topographic Maps. Part 3 of the DMA catalog "Topographic Products," has six volumes, each dealing with a portion of the world. The standard tactical maps listed in this very extensive catalog are generally used for ground navigation

and provide topographic information for a detailed terrain analysis of the bare base site and its surrounding areas. These topographic products can also be ordered through base operations.

12.3.3.2.6. Climatic Data. The Air Force Climatology Applications Center (AFCAC) should be able to provide you with all the data you will require. Requests for ETAC's support should be addressed to:

AFCAC
Scott AFB, IL 62225

You should furnish AFCAC a concise statement of your requirements in terms of either the environmental factors involved or of the climatological information desired. Probably a majority of the data you will require for your planning already exists in published form and in the open literature. Much of it can be found in official government publications. It will also occur in a wide variety of climatic and geographical textbooks and even in some travel guides.

12.3.3.2.7. Commercial/Government Literature. Another source of general foreign country information can be brochures and publications written by the countries themselves. Contact the respective U.S. Embassy or Consulate for such data.

12.3.3.3. Weather and Terrain. It is essential that you recognize the terrain's limitations and opportunities very early in the planning process. Since most terrain factors are effected in some way by the weather, it is equally important for you to understand what these relationships are in the climatic region in which the bare base site is located. The following section presents some specific planning considerations as they relate to four major climatic zones -- temperate, tropic, frigid, and desert (the Arctic has been excluded from consideration). Use the guidelines which are applicable to your region as a checklist during your site specific planning.

12.4. Environmental Considerations. Unfamiliar environmental conditions can severely affect civil engineer operations. Environmental extremes usually require specialized techniques, procedures, and equipment. Since there are over 1,200 potential bare base locations scattered throughout the world, the discussion of environmental considerations is limited to those which are deemed most essential for your planning efforts.

12.5. Temperate Zone. The temperate zone extends throughout the world and, very generally, includes the variable climates of the middle latitudes, between the extremes of the tropical and frigid climates. The temperate zone is divided into intermediate hot-dry and intermediate cold regions.

12.5.1. Intermediate Hot-Dry Regions. Intermediate hot-dry climates are prevalent in parts of the North American continent, Europe (Southern Spain), Africa, Asia, and Australia. Operational conditions include four hours with an ambient air temperature over 105 degrees Fahrenheit, an extreme temperature of 110 degrees Fahrenheit for not more than one hour, a maximum ground temperature of 130 degrees Fahrenheit, and a wind velocity of 5 to 10 knots during the period when the temperature is above 105 degrees Fahrenheit. A rainfall of 9.5 inches (maximum intensity: 0.45 in/min) during a 12-hour period is possible. Rains may be accompanied by intermittent wind velocity of 35 knots. Sites may be subject to winds of 45 knots for a 5-minute period; gusts may reach 65 knots. Snow and icing conditions are non uncommon in parts of the area designated intermediate hot-dry.

12.5.2. Intermediate Cold Regions. The intermediate cold regions of the temperate zone are located in the northern hemisphere and, as mentioned earlier, in the middle latitudes which encompass Iceland, central Europe, parts of Asia (including the Korean peninsula), and some of the higher latitude coasts, the southern coast of Alaska, for example, where maritime effects prevent the occurrence of extremely low temperatures. The intermediate cold region of the temperate zone encompasses much of NATO's Allied Command Europe, which is best characterized by the cold and wet environment of Germany. Although there are warm, sunny days in summer and snow prevails in winter, low overcast with rain prevails. During fall, winter, and early spring, the fog frequently does not lift until midday. On about one third of fall and winter mornings, visibility is less than one mile. The cloud layer over Western Europe is typically low with easterly movement; ceilings are 1,000 feet or less during the December - February period. In the winter season, there may be days when the ambient air temperature drops to minus 25 degrees Fahrenheit for six continuous hours. Infrequent wind velocities greater than 10 knots can be expected when temperatures are that low. Winds are generally less than 10 knots, solar radiation is negligible, and humidity tends toward the saturation point.

12.5.2.1. The urbanization of Central Europe, particularly Germany, has a major impact on military operations. Hundreds of towns and cities have populations over 50,000. Small villages have grown together and often completely surround air bases. The boundaries of these air bases were fixed 30 to 40 years ago and have not been expanded even though each year has seen new missions and buildings added. Locations of new facilities during deployment to such crowded bases is driven largely by the remaining open space.

12.5.2.2. The Korean peninsula is a rugged, mountainous area with short, hot, and humid summers and long, cold winters. The heavy rains that occur from June to September often cause damaging floods. Similar to Western Europe, air bases in Korea are crowded and surrounded by urban growth or extensive rice paddy agriculture.

12.5.3. Planning Considerations.

12.5.3.1. **Site Access.** Avoid dense brush, timberland, and rolling terrain requiring heavy clearing or grading. In your terrain analysis, study slopes, drainage, vegetation, soil characteristics, flood-prone areas and any other unusual conditions affecting site development.

12.5.3.2. **Soils.** The free-draining, coarse-grained soils which predominate in most regions of the temperate zone make the best subgrade and subbase materials and exhibit almost no tendency toward high compressibility or expansion.

12.5.3.3. **Roads.** Roads should be located on soil composed of grained, non-frost susceptible materials in those regions of the temperate zone which are prone to frost heave. Where drifting snow can be expected, roads should generally be higher than the prevailing ground elevation and should not be constructed where existing vegetation or planned facility locations could block snow removal.

12.5.3.4. **Solar Orientation.** Plan to locate facilities so that energy consumption will be minimized without violating the concepts of functional grouping and dispersal (chapter 9). In the intermediate hot-dry environment of the temperate zone, shelter wall exposure to the sun should be minimized by orienting the facility's longer side along an east-west axis. In intermediate cold regions, orient facilities so the longer sides of shelters are along a north-south axis to provide maximum solar radiation on walls.

12.5.3.5. **Wind Orientation.** The velocity varies with each particular area and season. Maximum wind speed occurs during periods of changing temperatures and prolonged velocities above 90 knots have been recorded. Snow and silt begin drifting with winds above eight knots.

12.5.3.6. **Site Drainage.** Grade the soil away from exterior walls by use of drainage swales.

Fill in low spots or grade to drain.

12.5.3.7. **Water Supply Requirements.** The water use planning factor for the temperate zone is 50 gallons per person per day.

12.5.3.8. **Water Sources.** In the temperate zone the best source is surface freshwater from lakes and streams. Other sources include the host nation water system, fresh groundwater (wells, springs, well points), seawater in coastal areas, and brackish water from swamps, ponds, or wells.

12.5.3.9. **Water Treatment.** The ROWPU is the primary equipment used to produce potable water from seawater and brackish ground and surface water.

12.5.3.10. **Water Storage.** Provide a 50 percent reserve for peak loads and emergencies. In the intermediate cold regions make provision for freeze protection (see chapter 7). Immediately consider reducing water consumption (rationing) if more serious longer term problems arise such as major equipment breakdown or battle damage.

12.5.3.11. **Water Distribution.** Use polyvinyl chloride pipe, pressure class 150. If pressure and temperature exceed 150 psig and 140 degrees Fahrenheit, respectively, select steel or reinforced concrete piping. Emplace pipe below frost line. Above ground piping should be electric traced or insulated to prevent freezing. Where heat tracing is required, use metal pipe.

12.5.3.12. **Sanitary Systems.** Assure that sewer lines are installed below frost level.

12.5.3.13. **Foundation Requirements.** Spread or strip footings are most common for moderate loads. Carry depth below the frost line. Allowable bearing values vary due to varying soil and subsurface conditions. Use a thickened edge slab with lightweight structures where some slab cracking is permissible. Thickened edge slabs should only be used on native or imported coarse-grained soils. Use treated timber or concrete for foundations. Use treated wood, steel, or concrete piling where loads and low bearing soil dictate.

12.5.3.14. **Concrete Placement.** In cold weather below 50 degrees Fahrenheit, use type III or air entrained cement, or use richer mixes. Enclose the site with tents or use space heaters to keep the concrete warm. Keep forms on longer and, in very cold weather, insulate all around. Speed up strength gain by using calcium chloride (2 percent by weight of concrete).

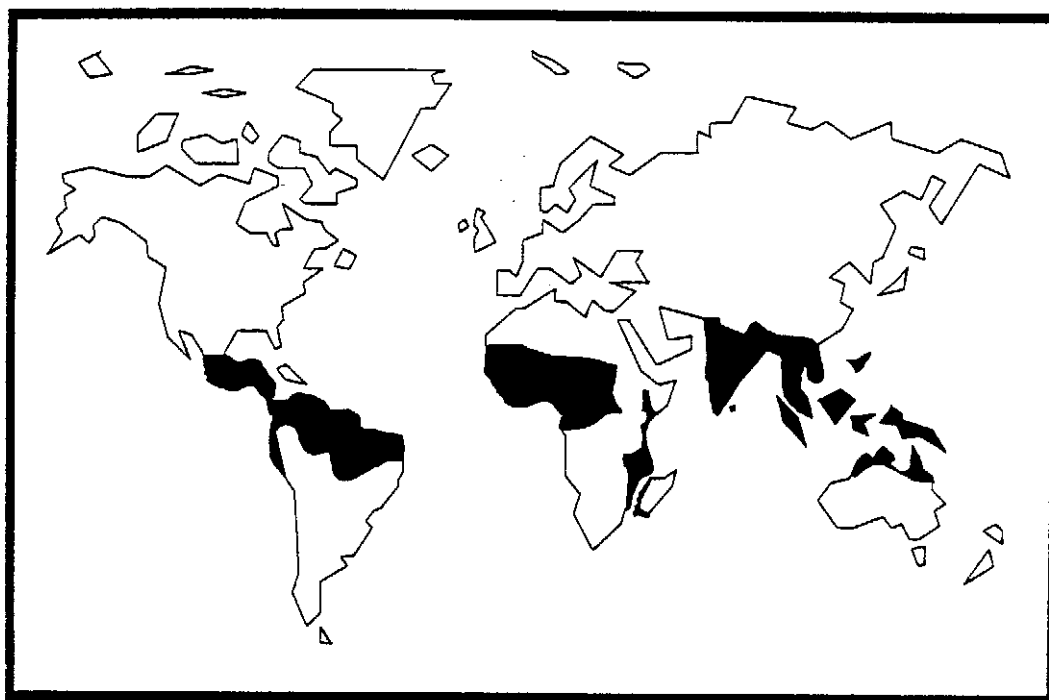
12.6. Tropical Zone. Wet-warm regions in the tropical zone coincide with the major tropical rain forest areas of the world (figure 12.1). In the western hemisphere this area extends from the southern tip of Mexico through Central America to South America. Wet-warm conditions also prevail in the heavily jungled areas of Central and East Africa, Southeast Asia, the Asian Islands (Sri Lanka, Sumatra, Malaysia, Indonesia, Philippines, and New Guinea) and the northern coast of Australia. Wet-hot conditions, characterized by high temperature and humidity, and intense solar radiation, are found in the open in tropical areas where rain forests give way to deciduous and secondary forests, and tropical savannas. The discomforts of tropical climates are often exaggerated, but it is true that the heat is more persistent. Many people experienced in the tropics feel that the heat and discomfort in some US cities in the summertime are worst than the climate in the jungle. Strange as it may seem, there may be more suffering from cold in the tropics than from the heat. Of course, very low temperatures do not occur, but chilly days and nights are common. In some tropical areas, in winter months (the reverse season below the equator), the nights are cold enough to require a wool blanket for sleeping. Rainfall in many parts of the tropics is much greater than that in most areas of the temperate zones. Tropical downpours usually are followed by clear skies, and in most places the rain are predictable at certain times of the day. Except in those areas where rainfall may be continuous during the rainy season (for example, in Southeast Asia and Asian Islands), there are not many days when the sun does not shine at least part of the time.

12.6.1. **Planning Considerations.**

12.6.1.1. Site Selection. Proper site selection for bare base development is the most important element in the tropical zone. Subgrade soil characteristics, groundwater and surface drainage are prime considerations for the planner.

12.6.1.2. Site Improvements. Site improvements at a bare base located in the tropics will generally involve construction and maintenance of taxiways, parking aprons, roads, and protective revetments and shelters. The dense vegetation, gullies, cliffs, steep slopes, and streams often found in the proximity of airfields complicate construction in the tropics. The heavy rainfall imposes a drainage problem of major concern. Ground water is usually found a few inches below the surface, requiring special attention to subgrade drainage. Because of the ponding potential of surface water, parking aprons should be located on the runway's downhill side. It is advisable to cut the right-of-way of roads much wider than normal so that the sun can dry the roadbed. Good fill material is often difficult to locate in topical environments. Frequently, the soil is decayed vegetation which must be replaced regularly. Most soils will have high clay content which do not drain well and are difficult to compact. Bare base roads constructed of such materials fail under heavy traffic when wet; when they must be used, good drainage is vital.

Figure 12.1. Wet-Warm Regions in the Tropical Zone.



12.6.1.3. Solar Orientation. Despite the availability of air conditioning equipment, adequate protection from the sun should be provided to maintain a comfortable internal temperature for facilities (particularly Harvest Falcon/Eagle shelters). Shading can be accomplished by tree cover, man-made screening, camouflage netting, or a combination of these methods. When the bare base site features rolling or hilly terrain on its environs, shelters can be placed on the shaded slope (north slope in the northern hemisphere, south slope in the southern hemisphere) to reduce exposure to solar radiation. On flat terrain, shelters should be sited in an east-west direction which minimizes wall area exposure to the low angles of early morning and late afternoon sun. Reflected radiation also poses a problem in the tropics; avoid siting shelters near large paved areas or bodies of water.

12.6.1.4. Wind Orientation. Wet regions in the tropical zone are characterized by mild trade winds which blow the same direction for most of the year. High velocity winds occur from several directions during the monsoon season. Effective use of breezes sometimes provide the only relief to oppressive heat; nevertheless, solar orientation of facilities and shelters should take precedence over wind orientation.

12.6.1.5. Water Supply Requirements. Use a water planning factor of 50 gallons per person per day in the tropical zone.

12.6.1.6. Water Treatment. Primary equipment used to produce potable water from seawater and brackish ground and surface water sources will be the ROWPU system.

12.6.1.7. Water Storage. Provide a 50 percent reserve and install screens to protect storage facilities from insects and animals. Use bladder pillow tanks where feasible for initial and elevated storage for temporary construction.

12.6.1.8. Water Distribution. Protect buried water distribution lines from movement because of expansive soils. Use inert sand or gravel base for bedding and backfill. Above ground piping should be insulated and protected with mold-resistant covering.

12.6.1.9. Electrical Power Generation. Advance planning should provide for generators to be conditioned for operation in a high humidity, fungus promoting atmosphere.

12.6.1.10. Interior Electrical. Electrical equipment used in the tropics must be specifically designed for use in this zone.

12.6.1.10.1. Use circuit breakers with bimetallic thermal elements treated to prevent corrosion or galvanic action, or replace them with suitably sealed or protected solid state tripping devices.

12.6.1.10.2. Use porcelain or fungus and corrosion resistant plastic switches and receptacles.

12.6.1.10.3. Equip motors larger than 1 hp and generators rated above 10 kW with heaters which are energized when the units are not running.

12.6.1.11. Exterior Electrical. Special requirements to be considered are:

12.6.1.11.1. Request salt spray test certification for equipment used in salt laden atmospheres.

12.6.1.11.2. Use oil filled transformers which are hermetically sealed or equipped with inert gas provided by a nitrogen cylinder.

12.6.1.11.3. Use silicon bronze, copper, aluminum encased steel, or hot dipped galvanized steel hardware.

12.6.1.11.4. Use jute protected double-type armored type cables when directly buried in coral backfill.

12.6.1.11.5. When buried, use cable which is resistant to roach, termite, and microbial attack and ensure that splices are waterproof.

12.6.1.12. Foundation Requirements. Several advantages suggest raised point foundations as the best solution for the tropics. This type of foundation absorbs much less of the stored heat from the ground, allows the floor system to be cooled by natural ventilation, and separates the structure from the high moisture content of the ground. Slab-on-grade systems do work in tropical areas, but moisture problems result and heat is reflected from the ground.

12.6.1.13. Concrete Placement. The following procedures are recommended when the temperature exceeds 90 degrees Fahrenheit:

12.6.1.13.1. Keep all materials cool and store cement in shade.

12.6.1.13.2. Spray the gravel with water and, if necessary, use ice water in the mix.

12.6.1.13.3. Set up wind breaks to prevent rapid evaporation.

12.6.1.13.4. Work at night when temperatures are lower.

12.6.1.14. Unique Structural Considerations.

12.6.1.14.1. Treated timber should be used where wood is in contact with soil or concrete.

12.6.1.14.2. Where field painting is required, structural steel surfaces should be cleaned and primed using red lead or zinc chromate paint.

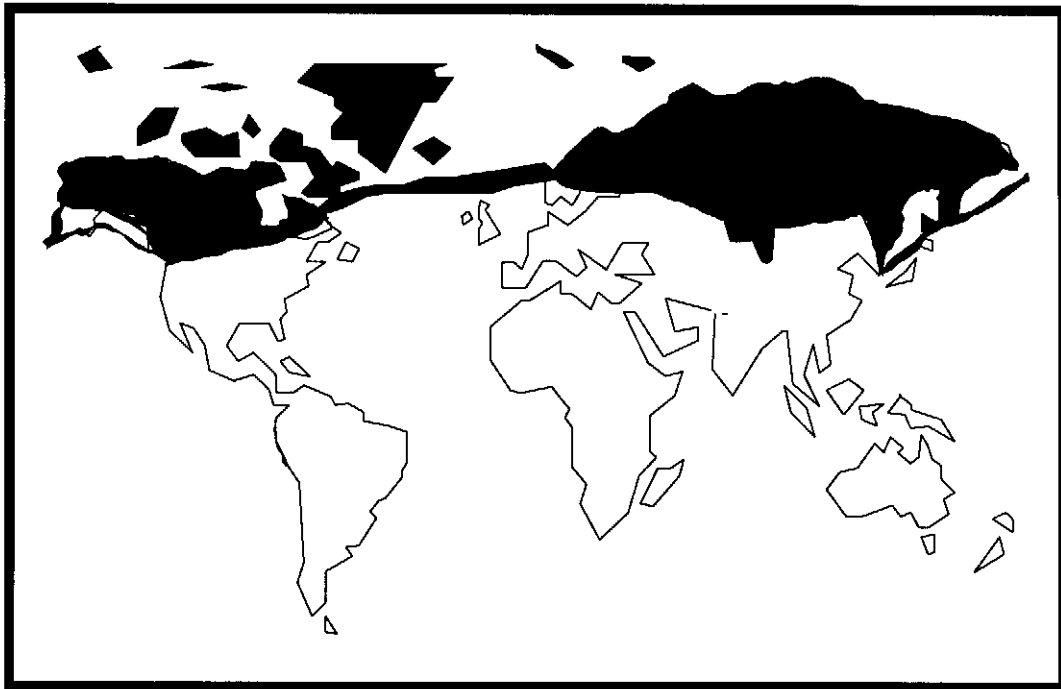
12.6.1.14.3. Aluminum alloys are excellent for use in this climate. When in contact with concrete, mortar, or plaster, aluminum gives better service if coated with synthetic or rubber-based paint.

12.6.1.14.4. Use galvanized steel fasteners; plain steel corrodes rapidly and promotes wood decay.

12.6.1.14.5. Use only paints, primers, and enamels which contain a fungicide to inhibit mold growth.

12.7. Frigid Zone. Frigid zone conditions are found in the northern hemisphere in Alaska, Canada, Greenland, northern Scandinavia, and northern parts of Russia and Asia. These northern regions comprise about 45 percent of the North American continent and 65 percent of the Eurasian land mass (figure 12.2).

Figure 12.2. Frigid Zone in Northern Hemisphere.



12.7.1. Planning Considerations. The frigid zone is characterized by deep snow, permafrost, seasonally frozen ground, frozen lakes and rivers, glaciers, and extreme cold. Besides climatic effects, bare base operations in northern areas are influenced by the vast distances and isolation commonly involved. Frequent high winds and either very short or very long periods of daylight prevail. Seasonably frozen ground may exist to depths as great as 12 feet. There is constant need for shelter and heat, increased dependence on special equipment and materials, and a need for special winter clothing. Cold temperatures make even simple tasks very difficult. During the summer, this zone may be characterized by numerous and extensive swamps, lakes, and rivers; abundant insects; and, at times, continuous daylight. Spring hazards include flash floods from snow and ice melt. Freeze-thaw cycles occur frequently. Engineers accustomed to operating in warm weather should be prepared for frigid conditions by proper training which should include operation of special-purpose equipment such as snow removal machinery and portable duct heaters. This training should also include winterization of standard bare base assets. Operation and maintenance of vehicles, power equipment, and utility systems in very low temperatures is difficult. Extreme cold may result in rapid deterioration of metal, plastic, and other materials. Special lubricants may be required, as well as antifreezes, protective covers, and warming equipment.

12.7.1.1. Temperatures. While temperatures vary considerably between locations during the winter season, six continuous hours with an ambient air temperature of minus 50 degrees Fahrenheit can be expected in the extreme northern parts of the frigid zone. Summer maximum temperature expectancy is 95 degrees Fahrenheit, well inland.

12.7.1.2. Winds. The velocity varies with the particular area and season. Maximum wind speed occurs during periods of changing temperatures and prolonged velocities above 90 knots have been recorded. Snow and silt begin drifting with winds above 8 knots. High winds combined with heavy snow can produce whiteouts capable of bringing movement to a standstill.

12.7.1.3. Icing Phenomena. In areas where there is a source of water vapor, ice fog occurs mainly at temperatures below 20 degrees Fahrenheit. At temperatures below minus 35 degrees Fahrenheit, ice fog may be very dense, limiting visibility to a few feet.

12.7.1.4. Site Access. Plan on using trees, shrubs, snow fences, or even structures to keep drifting snow from reaching the site proper. In a nondispersed layout, leave enough space between shelters to permit snow removal and locate structures in rows perpendicular to the wind. Dispersed shelters should be oriented with their longest axis parallel to the wind. In your site planning you must provide for snow-dumping areas downwind to eliminate large piles of snow and windrows in the camp area.

12.7.1.4.1. Locate major heat producing facilities, including heated shelters and shops, downhill and downwind from the runway to guard against ice fog.

12.7.1.4.2. At least 150 feet should remain open between the near edges of parallel runways and taxiways to provide dumping space for removed snow.

12.7.1.4.3. Parking aprons should be minimum width to facilitate snow removal and should permit maximum access to planned hangar locations, taking into account the prevailing winds. Locate parking aprons on the uphill side of the runway because of the ponding potential of the surface water. Parking aprons should be placed alongside - not upwind or downwind - of hangars and maintenance facilities.

12.7.1.4.4. Locate priority facilities toward the downwind end of the bare base where they are afforded protection by less important upwind shelters.

12.7.1.4.5. When planning to locate a facility, such as a ROWPU, near a stream or river, be sure to check your topographic data for the region to determine the maximum high water level resulting from spring thaws, ice jams, and similar conditions.

12.7.1.5. Road Construction. Mobility on the bare base may vary considerably during the winter season in the frigid zone. On frozen ground with minimal snow cover, trafficability is generally excellent. Marginally frozen soils, tundra, and thin frozen crust rapidly break down under the heavy traffic that can be expected at the deployment site. Where no permafrost is found, road construction design and procedures are generally the same for a frigid area as for a temperate climate. In permafrost regions where both wooded and open areas are available for road locations, it is better to cut through the wooded section for the additional protection trees offer against degradation of permafrost by radiant heat. Trees also protect against strong surface winds and attendant snow drifts. Roadway grades should not exceed 3 to 5 percent to provide adequate vehicular wheel traction (wheeled vehicle mobility in deep snow can be improved by reducing tire inflation pressure up to 50 percent). Roads require a sloping crown for surface drainage in summer and a flat crown for maximum traction and safety in the winter. Spring and fall grading operations for unpaved roads should be an expected requirement. Shoulder slopes of 5:1 should be used to prevent snowdrifts in open areas. Slopes may be a conventional 1-1/2:1 in protected areas. For longitudinal elevations, avoid cut sections where possible. Fill sections with minimum slopes of 4:1 should be used.

12.7.1.6. Solar Orientation. In subarctic areas, the long axis of shelters should generally be in an east-west direction to take advantage of the maximum solar exposure. However, since the solar radiation received is quite small, the direction of prevailing winds should be the deciding siting factor. Major bare base roads and the longer axis of shelters should parallel the prevailing wind direction.

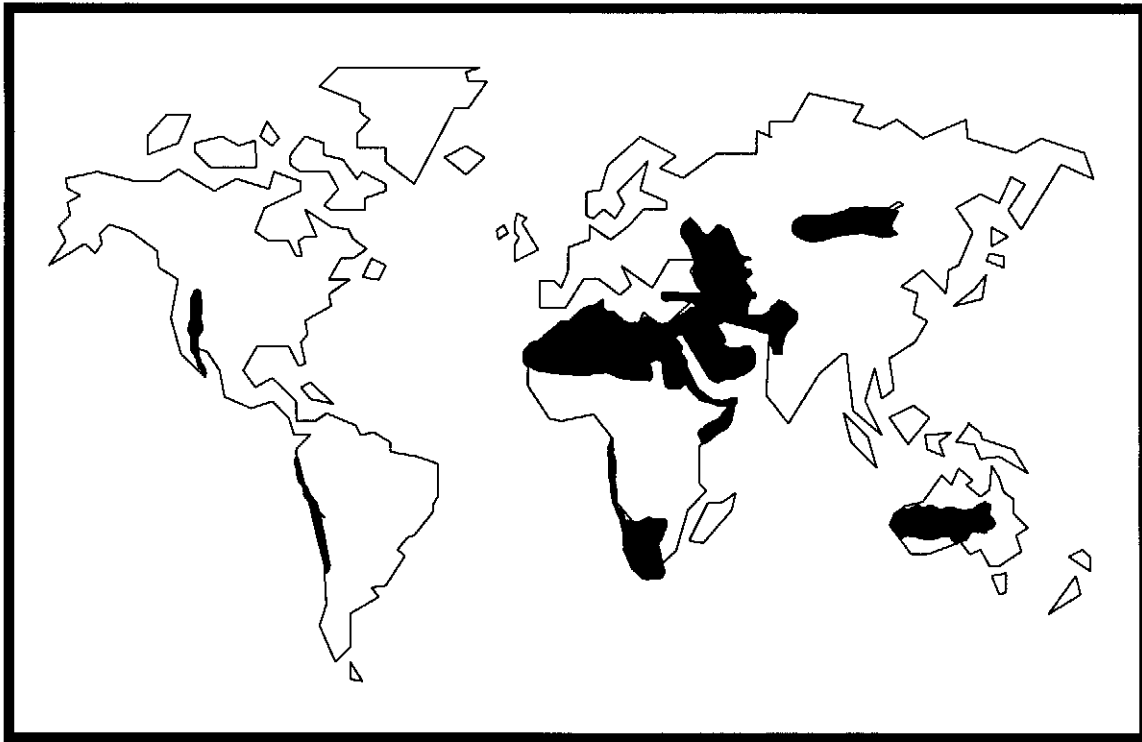
12.7.1.7. Utility Systems. Adequate planning will be required to provide the necessary freeze protection. For water storage and distribution, preheating the water at the source, using the M-80 water heater, should be one of your first considerations. Where feasible, use electric trace and insulated lines.

12.7.1.8. Field Sanitation. Maintaining proper field sanitation in a frigid climate presents some unique problems. Edible garbage should be burned to avoid attracting roving animals, bears in particular. Get the pest managers involved in planning to control the rats and mice which you can expect to find in great numbers in most of the habitable cold regions of the world.

12.8. Desert Zone. The desert zone, for the purpose of this discussion, is described as two different climatic subzones: the hot-humid coastal desert and the hot-dry interior desert environment. Characteristics common to both desert subzones are an arid, barren environment with stark contrasts of temperature, terrain, vegetation, and weather. Figure 12.3 portrays the desert areas of the world. Temperatures vary according to latitude and season, from over 136 degrees Fahrenheit in Mexico and Lybia to the bitter cold of winter in the Gobi in East Asia. In some desert areas, day to night temperature fluctuations can exceed 70 degrees Fahrenheit. Annual rainfall may vary from zero to 10 inches but is often totally unpredictable. Desert terrain also varies from place to place, the sole common denominator being lack of water with its consequent environmental effects.

12.8.1. Coastal Desert. Hot-humid conditions are limited to the immediate coast of bodies of water having a high surface temperature, such as the Persian Gulf and the Red Sea. These areas experience the highest water vapor in the world. In these coastal desert regions relatively high temperatures (about 100 degrees Fahrenheit) often combine with large amounts of water vapor in the surface air. Higher temperatures occur occasionally, but humidity levels will not be as extreme. The reverse season daytime minimum temperature is 32 degrees Fahrenheit. Nighttime temperatures are moderate: 60 to 80 degrees Fahrenheit in summer and 30 to 50 degrees Fahrenheit in winter.

Figure 12.3. Desert Areas of the World.



12.8.1.1. You can expect a one-hour rainfall of 4 inches with a maximum intensity of 0.45 inches per minute and an intermittent wind velocity of 35 knots. The annual total and frequency of rainfall are much less in the hot-humid and hot-dry desert climates than in the tropical and intermediate climates. When precipitation occurs, however, rainfall is often a quick, violent deluge causing flash flooding.

12.8.1.2. Bare base sites will be subject to winds of 45 knots for a 5 minute period with gusts to 65 knots. Prevailing winds blow from northwest or southeast almost exclusively.

12.8.2. Hot-Dry Subzone. Hot-dry conditions are found in the deserts of Northern Africa, the Middle East, Pakistan and India, Southwest United States and Northern Mexico, and in Australia. During the hottest month in a normal year the temperature may be above the intermediate hot-dry extreme of 100 degrees Fahrenheit more than 10 percent of the hottest month. In Northern Africa temperatures exceed 120 degrees Fahrenheit as much as one percent of the hottest month. Substantial desert areas on all continents have long periods with temperatures above 100 degrees Fahrenheit in the hottest month. The temperatures cited are shelter shade temperatures taken 4 to 6 feet above the ground. Equipment operating in direct sunshine will be exposed to temperatures 30 to 50 degrees higher than the shade temperature.

12.8.2.1. Humidity in the hot-dry desert subzone is low, ranging from 5 to 20 percent. During the reverse season, you can expect a minimum temperature of about 25 degrees Fahrenheit.

12.8.2.2. A one-hour rainfall of 4 inches with a maximum intensity of 0.45 inches per minute and an intermittent wind velocity of 35 knots can be expected. Temperatures during heavy rainfall will be lower than 80 degrees Fahrenheit.

12.8.2.3. Sites are subject to winds of 45 knots for a 5 minute period with gusts to 65 knots. Prevailing winds blow from northwest or southwest almost exclusively.

12.8.3. Planning Considerations.

12.8.3.1. Site Access. Of the several land forms found in the desert zone the Piedmont, Coastal Plain, and Mesa are the most suitable for site development and are the ones most likely to have water sources nearby. An increase in elevation in the Piedmont and Mesa regions causes the temperature and the relative humidity to decrease. Wind ventilation is also greatly improved. The Piedmont area slopes down from the mountains. Slopes facing away from the equator are preferable because they receive less solar radiation and have lower temperatures. Coastal Plains slope toward the sea and suffer from high humidity. If your planned site will be located in this area, water availability and wind circulation will be important planning considerations.

12.8.3.2. Trafficability. In the desert, rainfall and drainage seldom present problems. Soil is normally trafficable to all-wheel drive vehicles. After prolonged traffic, dust and blowing sand will become bothersome. Dust control can be achieved with minimal compaction and expedient grading effort followed by sprinkling with an asphalt emulsion, diesel or fuel oil, or even crude oil. Saltwater is a good treatment for unpaved roads at the bare base site.

12.8.3.3. Solar Orientation. Plan on locating bare base facilities with their long axis in an east-west orientation to minimize exposure to the low angled sun and to reduce the creation of shadows.

12.8.3.4. Wind Orientation. Winds in desert areas are practically unceasing and can achieve almost hurricane force. Because the wind moves great amounts of hot dry air, it has severe dehydrating effects. The wind always carries fine soil particles which clog mechanical systems and accumulate on every surface; it can also restrict visibility to a few yards. The Sahara "Khamseen," for example, can last for days at a time, although it normally only occurs in the spring and summer. The deserts of Iran are equally well-known for the "wind of 120 days," with sand blowing almost constantly from the north with wind velocities of up to 75 miles per hour. At the bare base the wind must be lifted, deflected and guided with a perimeter berm of height equal to shelter height, particularly on the prevailing wind side. You might also consider placing the long side of the bare base tentage perpendicular to the prevailing wind. Experience has shown this orientation is beneficial toward keeping sand out of the tents.

12.8.3.5. Site Drainage. In your site layout, avoid low lying areas - called "wadis" in the desert. When rain does occur, it is usually sudden and intense, and causes flash flooding. Rainfall generally occurs periodically during the winter season.

12.8.3.6. Water Planning Factor. The scarcity of water in the desert zone makes proper water planning, conservation and discipline critical issues. Use a water planning factor of 20 gallons per person per day.

12.8.3.7. Water Sources and Treatment. Plan on using the ROWPU to produce potable water from seawater, brackish ground and surface water sources. Resupply aircraft, tanker trucks, water trailers, and bulk containers or pillow tanks strapped to flat bed trucks comprise additional water sources. Well water is available at various depths under most deserts; however, such water is seldom of potable quality without employing a reverse osmosis water purification process.

12.8.3.8. Water Storage. In the desert, every effort should be made to store drinking water at a temperature of 70 degrees Fahrenheit. Earth cooling and night radiation could be used for cooling if mechanical cooling units are not available. Make provisions to use water chillers with water trailers or alternate bulk storage containers to provide small quantities of cool water reserved for human consumption only.

12.8.3.9. Water Distribution. Water distribution in a worst case environment - the desert - was described in chapter 7. However, in certain desert areas exposed water distribution lines (flexible hose type) must be insulated to prevent freezing.

12.8.3.10. Electrical Power Generation. It will prove prudent to plan on the installation of sun screens to protect the equipment from the intense solar radiation, wind blown dust and creeping sand dunes. Enclosures are not practicable due to the excessive heat buildup. Equally important will be your efforts to provide for additional generator cooling capacity, using add-on radiators to allow operation above their rated ambient temperature, normally 125 degrees Fahrenheit.

12.8.3.11. Electrical System Operation. Generator output is somewhat degraded under desert conditions but will continue to operate until one of several of the following devices is automatically triggered: high water temperature, high oil temperature, low fuel level, low oil pressure, or high alternator temperature. Some safety cutoffs can be manually overridden in critical situations. However, low oil pressure and high alternator temperature never should be overridden.

12.8.3.11.1. Plan on maintaining an adequate replacement parts supply since the expected generator failure rate is above normal.

12.8.3.11.2. Underground or on-the-ground power distribution is recommended in the desert zone. On-the-ground cable should be protected from sunlight and blowing sands as much as practicable. Road crossings should be underground and protected by use of PVC conduit.

12.8.3.12. Sanitary Systems. Expect a minimal sewage flow due to water scarcity. In areas with acute water shortage, you may want to consider recycling of wastewater from showers and laundry for non-potable purposes such as dust abatement, concrete mixing, firefighting, and aircraft and vehicle washing.

12.8.3.13. Shelter Foundation Requirements. Sand, when confined and compacted, makes an excellent base or foundation for bare base shelter facilities. Wind erosion, particularly at the corners of shelters, can be prevented by a gravel backfill or chemical stabilization. Drifting sand can be controlled by placing snow fences at critical locations.

12.8.3.14. Ventilation Considerations. Use the wind to every advantage for ventilation. Hot, dry daytime winds must be lifted, deflected, or guided away from shelters. In low humidity regions with large variations between day and night air temperatures, ventilation should be as high as possible at night to cool down the interior walls. During the day, the ventilation should be as low as possible so that hot air will not raise the temperature of interior surfaces. In high humidity (coastal desert) regions with little change between day and night air temperature, there should always be ventilation for facilities not served by air conditioning.

12.9. Comprehensive Base Development Plan. The preceding sections of this chapter focused attention on the initial aspects of site specific planning - the diligent process of gathering all relevant climatic and topographic data from a variety of the sources which were identified. These data, supplemented by the general planning considerations for the climatic zone applicable to your base, must now be integrated with the information on existing features of the bare base site - runways, taxiways, ramps, aprons, facilities, utilities, and the presence of any other man-made or natural resources that affect the conduct of future operations. The sum of these data, when overlaid by the results of the mission and threat analyses, should yield the information needed to proceed with the first stages of the combat air base planning process discussed in chapter 2. Once this planning process is completed, you should have a definitized base development plan to use as a starting point for physically accomplishing a bare base beddown operation.

12.9.1. Harvest Falcon Use. When Harvest Falcon assets are used to satisfy beddown facility and utility requirements, many of the combat air base planning decisions are arbitrarily made for you. For example, the type of facility to be used is predetermined, facility space allocation (square footage) is preordained, and utility service, for the most part, is prepackaged and sized. To illustrate how Harvest Falcon assets might interface at a bare base location, let's look at a hypothetical beddown operation of three fighter squadrons, each having a supporting population of 1,100 people.

12.9.1.1. It is unlikely that all aircraft and all personnel will arrive at the beddown location on the same day. Usually aircraft flow is staggered and supporting personnel and equipment tend to cluster around aircraft arrival times, some arrive earlier - some later. The first squadron and its 1,100 people would require the Harvest Falcon asset echelons shown in column 1 of table 12.1. These echelons would include one housekeeping set, one industrial operations set, and one initial flightline set. These assets would probably not all arrive on the same day, but they should arrive, hopefully, in the order listed. Several factors must be considered concerning these first packages of Harvest Falcon assets.

Table 12.1. Harvest Falcon Beddown Example.		
ONE SQUADRON 1,100 PERSONNEL	TWO SQUADRONS 2,200 PERSONNEL	THREE SQUADRONS 3,300 PERSONNEL
<i>Housekeeping Set</i>	Housekeeping Set <i>Housekeeping Set</i>	Housekeeping Set Housekeeping Set <i>Housekeeping Set</i>
<i>Industrial Operations Set</i>	Industrial Operations Set	Industrial Operations Set
<i>Initial Flightline Sup Set</i>	Initial Flightline Sup Set <i>Follow-On Flightline Ops Set</i>	Initial Flightline Sup Set Follow-On Flightline Ops Set <i>Follow-On Flightline Ops Set</i>

12.9.1.1.1. Site layout planning must be accomplished with the fact in mind that additional aircraft and personnel will be arriving shortly. Space for a full 3,300 person cantonment area must be allotted along with adequate area for establishment of a maintenance complex suitable for three squadrons of aircraft. Utility systems must be laid out with the same considerations in mind - build utility plants with room for expansion and perhaps dispersion as the population increases. Quantity-distances for POL and munitions storage areas must also take into account the overall base layout dimensions and be sited where they will not be encroached by future facility placements.

12.9.1.1.2. Arrival sequence of individual Harvest Falcon assets may not permit the most efficient engineer operations. Assets should flow in a reasonable order, but single items are bound to show up which cannot be immediately used. Some items may arrive prior to when they are actually required, some may be later. A completed site layout can alleviate some of these problems by identifying end locations for all facilities and equipment items; however, you may want to consider preestablishing a "holding area" for assets that cannot immediately be installed or erected. Do not assume that assets can be stored on aircraft parking aprons until they are needed; find an area that you can control and have free access to at all times.

12.9.1.2. The second aircraft squadron and its 1,100 person complement would be supported by the additive assets highlighted in column 2 of table 12.1. The asset echelons include a second housekeeping set and a follow-on flightline support set. As shown in column 3, a similar package of assets (housekeeping and follow-on flightline sets) is provided to support the third squadron and its associated personnel.

12.9.1.3. The Harvest Falcon deployment packages also contain an inherent quality of flexibility to meet varying demands. If bare base operational requirements for facility support grow larger than can be reasonably accommodated by the standard

deployment echelons, smaller subsets of facility packages can be provided. For example, if the industrial operations set becomes overtaxed in terms of operational space, additive facilities for such as functions as general purpose storage or shops can be sent. These smaller subsets are identified by individual unit type codes (UTCs) under the umbrella of the primary deployment set. Conversely, if a base population only reaches 2,800 with the addition of a third aircraft squadron, the third housekeeping set can be appropriately decremented to this population requirement by tailoring out cantonment type UTCs.

12.9.2. Existing Facilities and Resources. In any future bare base deployment time will be a critical factor. Given the many possible contingency scenarios which may constrain the airlift of bare base equipment, materials, and supplies, your imaginative and prompt approach to planning the use of existing resources at the deployment site will be a key determinant of success or failure of the engineer support mission. Working and living space provided by mobile facility assets will only meet minimum essential requirements. Do not turn down any reasonable opportunity to use existing facilities to cover facility space shortfalls, improve working and living conditions, or supplement mobile assets.

12.10. Supplies and Construction Materials. Since most engineering work to provide bare base upgrades, expansions, or repairs requires large quantities of materials, no potential source should be ignored. Many potential sources of supplies and construction materials exist at overseas locations. The challenge is to locate the needed materials, then determine the method to acquire them. Sources may be on base, in the local area, in-theater, or in CONUS.

12.10.1. Base Supply. The first place to check is the official source, the standard base supply system. In some overseas locations, USAF main operating bases support deployment sites by processing requisitions. The engineer planner can expedite supply requisitioning by providing supply the current stock numbers of common engineering materials. The nomenclature of AM-2 mat and accessories, steel bin revetments, sandbags, and lumber may mean little to a harried supply specialist; valid stock numbers mean everything. Materials not in stock locally will be backordered from CONUS by base supply and shipped in by air or sea, depending on priority. In a large contingency, airlift will be severely constrained and it is not reasonable to expect that more important cargoes will be preempted by construction materials.

12.10.2. Headquarters Staff. An important source of material support are the staffs at Numbered Air Force or MAJCOM headquarters. These staffs are generally aware of other in-theater assets, either prepositioned war readiness matériel or stockpiles of deployed materials not in the standard supply system which may be available to support your mission, depending on your base's priority with respect to other in-theater needs. Working through these headquarters elements, particularly those that might be in-theater or deployed forward, often produces results more responsive than standard requisitioning methods. The important point is you must ask for their help and keep asking -- they are there to assist you.

12.10.3. Other Engineer Units. If certain materials are either not available or carry an unacceptably long lead time, other local military engineer units should be considered as a potential source. These include the host nation base engineer, nearby host nation or U.S. Army combat engineer units, and U.S. Navy Construction Battalions (Seabees). Some of these units were valuable sources of supply for Air Force engineers during the Southeast Asia conflict.

12.10.4. Local Purchase. Another possible source of material is the purchase on the local economy. This is especially appropriate for bulky materials (cement, crushed stone, select fill, asphalt, and lumber) which require an undue amount of transportation when shipped from a distant source. Local purchases require assistance from procurement, finance, an interpreter, and a competent civil engineer person to identify the right materials (attachment 17 provides conversion factors, attachment 18 lists foreign weights and measures). Local construction contractors are familiar with nearby sources of engineering materials. Experience has shown that blanket purchase agreements with local suppliers work well during contingencies where response and delivery are critical. Cultural differences have definite effect on local purchase procedures. In many countries of Southwest Asia, for example, small businessmen are accustomed to working strictly on a verbal, cash basis. They may regard written contracts and invoices as unnecessary or even as an insult to their integrity. Prices generally are not fixed, but are established by bargaining. Blindly imposing American methods can cause resentment. Sensitivity to local customs is appreciated, even if the U.S. Air Force cannot always follow them.

12.11. Host Nation Support Agreements. Air Force units deployed in the past to Korea, and Vietnam and Thailand in Southeast Asia, often were tenants on bases belonging to the host nation. As tenants, Air Force civil engineers frequently relied on the host base engineer for assistance. The Air Force paid for much of this support, but even with reimbursement good working relationships were important to the progress of base development. At many of these bases Joint Support Plans (JSPs) or country-to-country agreements defined the responsibilities for both the tenant and the host. Future deployments will also benefit from good host relationships. Some installations in Europe and joint use bases in Korea are covered by JSPs which list the facilities the host nation has agreed to share with, or turn over entirely to US forces upon deployment. In other locations, such as Southwest Asia, US funded construction programs built facilities on host nation bases for US use during contingencies. For a base without a JSP or similar agreement executed prior to deployment, mutually acceptable arrangements for facility use, maintenance, work approval, and reimbursement may have to be worked out informally, and then approved by appropriate U.S. and host nation authorities.

12.11.1. Unpublished JSPs. Keep in mind that bases without a formal JSP may have been, nevertheless, surveyed by a site development or assessment team, particularly if the base supports a CINC OPlan. Results of an advance assessment should be available at the MAJCOM level. Your local logistics plans or operations plans shops should be able to give you an idea if your base is included as plan of a regional OPlan.

12.11.2. Other Host Nation Support. Besides facility support, host nation agreements can also outline materials and services to be provided. At most locations, local nationals can provide services such as refuse collection, construction equipment rental (with operators), supply delivery, custodial support, and even some basic maintenance support. If such services exist at your beddown location, use them to the fullest so that your people will not be burdened with these time and labor consuming tasks.

12.12. Hardening Requirements. If the threat analysis placed your planned base in a high threat area, hardening requirements have to be addressed. The simplest form of hardening is the construction of revetments of sandbags, soil filled steel bins, or soil filled containers of any type that can be stacked and fastened together to form a wall. Testing has shown that for expedient revetments a thickness to height ratio no less than 40 percent provides reasonable stability against tipping over from blast. While hardening effectively counters the threat from conventional munitions, it consumes great amounts of scarce manpower, materials, and, above all, time. Consequently, revetment construction should be planned according to the priority of the resources protected. Aircraft come first, followed by command post, communications, functional control centers, billeting shelters, water pumps and treatment plants, fire vehicles, remaining work areas, and so on as threat levels and other work dictate. Revetment descriptions are contained in chapter 5 of this volume; construction details are included in volume 2 of this pamphlet series.

12.13. Camouflage, Concealment and Deception (CCD) Requirements. Almost as costly in terms of manpower, time and materials are the application of CCD measures. The nature of the threat, the importance of the base mission, and the base vulnerability all bear on CCD requirements and priorities. To be practicable, CCD measures must concentrate on decreasing the range of target acquisition by delaying recognition of targets and by concealing or decoying valuable assets within the target area, thus hampering precision bombing. Use T.O. 11WA2-1-1 and the planning factors in volume 2 of this pamphlet series to calculate your requirements for using the standard camouflage net system. Camouflage net systems are included in the housekeeping sets of the Harvest Falcon packages.

Chapter 13

MANPOWER PLANNING



13.1. Introduction. Operational commands require organic civil engineer combat support to provide them the flexibility to employ their weapons systems without dependence on others. Civil engineer units are organic at essentially all major Air Force bases, and they are totally integrated into the peacetime force structure. A similar organic element, organized as Prime BEEF teams, will accompany each flying squadron deployed to a bare base. The support provided by these engineers will encompass everything from force beddown and routine operations and maintenance, to emergency and follow-on war damage repairs of the bare base. Each bare base our forces will deploy to will have different site conditions, airfield layout, and other criteria that will dictate the degree of site preparation and engineering effort needed to sustain the base complex, once developed. A typical bare base could be a commercial airport or allied military airfield on which the Air Force is given use of the runways, a water source, and an area for erection of bare base facilities. In some cases there may be some facilities and services that could be used in lieu of mobility support. For example, an allied military airfield may have adequate lighting, arresting systems, and fire protection services to support the deploying force's flying mission. In a few cases, billeting or some similar support may be available and would negate the need for erection of billeting and other facilities. Likewise, electrical power, water, and waste systems may fill the Air Force mission needs without further augmentation or development. Factors such as these will dictate the overall level of effort needed to establish, operate, and recover a bare base. The responsibility for identifying the specific engineer support requirements belongs with planners from both overseas theaters and gaining commands. To aid them in this endeavor, this chapter will assume a worst case scenario and that there is virtually no host nation beddown support, and no facilities, utilities, or services other than those provided in bare base support packages. Under this scenario, bare base operations will depend largely upon engineer Prime BEEF and RED HORSE resources.

13.2. Overview. This chapter describes the Prime BEEF concept of operation; the beddown force structure; phases of beddown operation; typical beddown, operations and maintenance, and base recovery tasks; and factors which affect the productivity of the engineer force.

13.3. Concept of Operations. Current thinking regarding the Air Force's role in national defense envisions a strategy based on a foundation of deterrence. This deterrence is comprised of several factors among which are a mix of nuclear and conventional forces, a forward defense, and power projection capabilities. While deterring nuclear attack will remain the first priority, deterrence using conventional forces will remain essential in addressing those local conflicts that could threaten U.S. interests and allies. This form of deterrence requires that U.S. forces be flexible, rapidly responding, precise, and lethal with global reach. Civil engineer forces posture Prime BEEF teams to support Air Force combat and air mobility forces in attaining these qualities. Prime BEEF personnel must be capable of mobilizing and deploying at least as fast as the flying squadrons they support; able to provide immediate beddown, fire protection, disaster preparedness (DP), and explosive ordnance disposal (EOD) support regardless of location; capable of performing base recovery quickly and effectively; and able to sustain air base operations irrespective of the age, condition, or type of facilities.

13.3.1. "Core Unit Type Code (UTC) Package" Concept. To deploy its forces in support of the national strategy, the Air Force uses the Core UTC Package (CUP) concept. This concept is designed to improve overall combat capability by establishing deployment relationships between combat forces and their support infrastructure. CUPs constitute the basic building blocks for constructing Air Force Time-Phased Force and Deployment Data (TPFDD).

13.3.1.1. A CUP normally consists of an aviation UTC and sufficient support designed to deploy to a Collocated Operating Base (COB). Most, but not all, UTCs required at a COB are included in the package. Since all destinations are not alike, CUPs must be adjusted during planning to fit the requirements of each destination by either adding or subtracting individual UTCs. Harvest Falcon or Harvest Eagle UTCs must be added, for example, at bare base locations. Essential engineer, fire protection, disaster preparedness, and explosive ordnance disposal functions have been included in all CUPs.

13.3.1.2. There are two types of CUPs, Lead and Follow-on. Lead CUPs normally include one independent aviation squadron UTC and sufficient support UTCs to open and maintain a COB. In the case of civil engineers, the Lead CUP contains the initial engineer element UTCs which include the requisite personnel, equipment, and command and control necessary to provide an initial cadre of engineer support. The Follow-on CUP contains those additional engineer UTCs required to augment the Lead CUP and provide the additional support required due to the increase in aviation assets and/or base population.

13.3.2. Engineer Employment Concept. The initial thrust of the Air Force response to crises or contingencies is normally the placement of combat and combat support forces (personnel) in theater as a deterrent force using the Core UTC package concept. If this deterrent force posture is not sufficient to limit enemy aggression, a warfighting force is fielded.

13.3.2.1. From a deterrent force perspective the basic components of the engineer portion of the Core UTC Package are the 132-person (104 engineers, 24 fire fighters, and 4 DP) **Lead Engineer UTC** and the 6-person **Lead EOD UTC**. The force elements are capable of providing initial beddown of a population of up to 1,200 people using expedient or existing facilities and follow-on operations and maintenance support of facilities and utilities and crash rescue/fire protection for a combat

aviation squadron of 18 to 24 tactical aircraft. It is also capable of limited base recovery operations to include rapid runway repair, UXO recovery/safing, and expedient repair of facilities and utilities if involved in wartime operations. These engineer **Lead** UTCs are normally deployed as an entity along with the aircraft package to a specific beddown location, but can be tailored, if necessary, to provide specific skills to specific beddown locations. If an aviation squadron is deployed as a part of a Follow-on CUP, its associated **Follow** engineer UTC is deployed with it but must marry up with a **Lead** engineer package at a final beddown destination. The engineer capabilities of the engineer **Follow** UTC, while similar to those of the engineer **Lead** UTC, do not have sufficient depth to provide fully responsive beddown support or accomplish sustained operations and maintenance. The engineer **Follow** UTC is not meant to be a stand alone function.

13.3.2.2. If a warfighting force posture becomes necessary, the engineer strength at a single beddown location is increased to 288 people (196 engineers, 48 fire fighters, 22 EOD, and 22 DP). One squadron of aircraft typically brings in 138 Prime BEEF personnel (104 engineers, 24 fire fighters, 6 EOD, and 4 DP). At some locations, the fact that two squadrons of aircraft have been deployed means a minimum of 203 Prime BEEF personnel (150 engineers, 36 fire fighters, 10 EOD, and 7 DP) are already available. Three squadrons of aircraft usually brings a minimum of 268 Prime BEEF members (196 engineers, 48 fire fighters, 14 EOD, and 10 DP). At locations where the aircraft flow does not bring in sufficient engineers and fire fighters, additional UTCs are required. These additional forces are normally provided from the Reserve force component. The capability of this warfighting force includes concurrently fielding a command and control function, damage assessment teams, damage assessment and response teams, NBC response teams, explosive ordnance safing and removal teams, utility and facility repair teams, crash rescue and fire suppression crews, and a rapid runway repair (RRR) team to repair six craters in four hours. If a warfighting scenario intensifies, the 288-person Prime BEEF force at each beddown location would be expected, for some period of time, to expand its RRR capability to the repair of at least 12 craters in four hours given the appropriate equipment sets. If additional forces are considered necessary, they come from the Reserve force component since there will be insufficient active duty forces to provide a full warfighting force capability concurrently at all beddown locations.

13.3.3. Logistic Support. It is essential that a logistical support relationship be established when Prime BEEF teams are deployed to a theater of operation. Full logistic responsibility must rest with the theater MAJCOM being supported. This responsibility should include but is not limited to intelligence, communications, coordination and liaison with other agencies, personnel replacement, medical evacuation, transportation and vehicle maintenance support, rations, ammunition, beddown and construction materials, POL, maps, blueprints, charts, and resupply. If engineer resources cannot reasonably be expected during the early phases of deployment and employment, the responsible theater MAJCOM must pursue other avenues to support the engineer teams; for example, host nation support and contract support. Engineer teams at each beddown location will provide their own capability to set up internal supply operations to include determining requirements and requesting, receiving, storing, and distributing items necessary to fill engineer needs.

13.4. Beddown Force Structure. Development of the bare base site, facilities, and utilities will be done by engineer forces deploying to the bare base from single or possibly several different Continental United States (CONUS) and theater locations. There can be several types of these forces; sometimes working alone, sometimes in combination.

13.4.1. Prime BEEF. Attachment 19 lists the various engineer teams that may be tasked to participate in beddown activities. From a bare base perspective the Prime BEEF **Lead** UTCs (totalling 104 engineer, 24 fire fighter, 4 disaster preparedness and 6 explosive ordnance disposal personnel) are the basic engineer manpower components. These **Lead** UTCs are sized to support a squadron of aircraft and a base population comparable to that associated with a standard Harvest Falcon/Eagle set (1,100 people). It must be remembered, however, that Prime BEEF teams are not heavily equipped, having only basic tool boxes and rudimentary team kits (except for EOD, which has drive-on/drive-off capabilities as well as all necessary equipment and explosives to operate). Vehicles, major shop machinery, and all materials must be provided either as part of other deployment support packages, prepositioned assets, or host nation or local contract support.

13.4.2. RED HORSE. RED HORSE squadrons are manned to provide highly mobile, rapidly deployable echelons to support force beddown requirements and to repair enemy-inflicted war damage. They also provide necessary support for the siting and installation of air transportable facilities and equipment. Special capability exists for well drilling and aircraft arresting system installation. RED HORSE forces are deployed with their own required heavy equipment, tools, and a limited amount of rations; however, it may take up to 30 days for all the equipment to join up with the deploying RED HORSE forces. Therefore, during the first 30 days of any anticipated bare base operations involving RED HORSE, prepositioned or indigenous equipment will be required. Bare base planners, however, must remember RED HORSE squadrons are a very scarce resource. Even with Reserve Forces fully mobilized, only a few RED HORSE Squadrons are available. If major concurrent construction activities at several bare base locations must be performed, rigid prioritization of projects must be maintained to avoid diluting and fragmenting RED HORSE efforts.

13.4.3. 49th Material Maintenance Group (MMG). The 49th MMG is a cadre of people possessing unique expertise on Harvest Falcon equipment. Under normal operations, the 49th MMG is manned for storage, supply accountability,

maintenance, training, and logistics planning responsibilities of Harvest Falcon type assets stored at Holloman AFB or at forward storage and maintenance locations. During bare base contingency operations, the 49th MMG cadre play major roles in the preparation for shipment, installation and erection, and on-site maintenance of Harvest Falcon facilities.

13.4.4. Other Engineers. Other heavy construction support, such as Army engineer construction forces, Navy SeaBees, or local contractors should be considered for special construction tasks, such as runway and taxiway resurfacing, addition of ramps and aprons, installation of aircraft arresting barriers, well drilling, large earth moving projects, and follow-on war damage repairs.

13.4.5. Local Nationals. A potentially large source of manpower is the hiring of local nationals (LN). Also known as indigenous labor, they are citizens of the host nation. During the Korean and Vietnamese conflicts, local nationals provided a major part of the work force to construct, operate, and maintain USAF facilities. Hired individually or by contractors, LNs have worked as equipment operators, electricians, carpenters, masons, and unskilled laborers. They have also been employed in the more traditional white collar jobs such as administration, engineering design, drafting, and production control. Availability of LNs in future deployments, especially the more skilled people, depends on local economic conditions. However, U.S. wages exert a powerful attraction, particularly in developing countries. If the host nation has mobilized for war, labor will be scarce, but even then military reserve units and national construction organizations may be able to assist in bare base development work.

13.4.6. Users. Individual organizations will erect their own shelters (Temper tents, ESCs, user unique ISO containers) with minimum technical aid from engineer personnel. If this requirement is circumvented and engineers are tasked to erect everyone's shelter, the total impact on scarce engineer resources will cause great delays in establishing utility systems and in the accomplishment of other critical tasks.

13.5. Manpower Requirements. As mentioned in chapter 3, bare base deployments normally occur with the phased movement of three distinct forces -- the advance force, the initial force, and the follow-on force. Engineer representation on the advance force site survey team can come from several sources, for example, from a headquarters staff, a RED HORSE squadron, or from the **Lead** engineer team scheduled to deploy to the location in question. The engineer component of the initial force will normally be the **Lead** engineer and EOD UTCs supporting the **Lead** flying squadron. For the follow-on force the engineer support will usually be provided by **Follow** engineer and EOD UTCs. As these engineer personnel arrive on location, their efforts become devoted to developing a functioning operational aircraft platform in the shortest timeframe possible.

13.5.1 Manpower Employment. There are two distinct phases of employment during a bare base operation: the erection and construction phase, and the operation and maintenance phase. The first phase is more manpower intensive than the second. Transition from the erection and construction phase to the operation and maintenance phase for all work functions will not necessarily occur at the same time. For example, power plants and electrical distribution systems may be installed well ahead of water and waste distribution systems. Runways may meet all lighting and aircraft arresting requirements and would transition immediately into the operation and maintenance phase. During this erection and construction phase, the most critical skills are utilities, electrical, power production, heating and air conditioning, liquid fuels, and equipment operations. The level of civil engineer support required during the erection and construction phase will not change radically at the lower base populations because the tasks of preparing taxiways and runways, installing runway lights, constructing POL and ammunition areas, and installing utility systems remain relatively constant regardless of base population levels.

13.5.1.1. Erection and Construction Phase. The prompt beddown of deploying units is critical to mission success at contingency bare bases. Rapidly expanding bare bases will require the minimum facilities essential for air combat operations. Selected existing facilities will have to be expanded or modified, or mobility shelters (Harvest Eagle/Harvest Falcon) will have to be erected. During the early stages of deployment, engineer duties will not only concentrate on force beddown but also on preparation of the base to withstand the shock of an air attack. Those activities include hardening of priority facilities and utilities, and stockpiling and dispersing of war reserve materiel. To provide enhanced base security from ground attack, heavy equipment operators will clear, cover, remove obstacles and sculpt terrain on and immediately off base to provide the air base defense force with fields of fire and to deny enemy and terrorist avenues of access to the base. If time allows prior to an attack, engineers attempt to isolate utility systems to reduce the possibility of additional damage resulting from an attack. Engineers may be working around the clock. Nighttime operations may or may not be lit, and heavy construction equipment will produce high noise levels throughout the base and surrounding area. Personnel may require time to become familiar with the base layout; as a result, disoriented vehicle and pedestrian traffic can be expected in unusual locations. Heavy construction vehicles may or may not be radio equipped or, if they are, may be operating in periods of radio silence, when drivers must work from written or verbal orders. The following list, although not inclusive, shows the magnitude of the work projected for the beddown phase (see attachment 20 for planning data associated with common beddown type projects):

13.5.1.1.1. Revetting unsheltered aircraft.

13.5.1.1.2. Laying aircraft matting for aircraft parking.

- 13.5.1.1.3. Constructing earth berms and dikes for fuel bladders.
- 13.5.1.1.4. Modifying existing facilities for alternate use.
- 13.5.1.1.5. Erecting bare base facilities.
- 13.5.1.1.6. Installing power generating systems.
- 13.5.1.1.7. Establishing water distribution points.
- 13.5.1.1.8. Installing airfield and perimeter lighting.
- 13.5.1.1.9. Providing all essential utilities.
- 13.5.1.1.10. Constructing earth berms for bomb dumps.
- 13.5.1.1.11. Constructing communications tower foundations.
- 13.5.1.1.12. Constructing sewage lagoons.
- 13.5.1.1.13. Hardening critical facilities and utilities.
- 13.5.1.1.14. Constructing protective shelters to enhance survivability.
- 13.5.1.1.15. Constructing defensive fighting positions, armories, vehicle fighting positions and command centers for the base defense force.
- 13.5.1.1.16. Laying out and cutting access roads and fire lanes.
- 13.5.1.1.17. Performing CCD measures.
- 13.5.1.2. Operation and Maintenance Phase. After engineer forces have provided initial beddown, operations and maintenance, and services of essential facilities and utilities are required to support bare base operations. The following functions are involved:
 - 13.5.1.2.1. Supporting force beddown of Air Force units and weapons systems.
 - 13.5.1.2.2. Accomplishing operation and maintenance functions for existing, as well as newly installed bare base facilities and utilities.
 - 13.5.1.2.3. Providing crash rescue and fire suppression.
 - 13.5.1.2.4. Providing liaison with the 49th MMG to ensure adequate Harvest Falcon technical expertise is available.
 - 13.5.1.2.5. Enhance base command and control and overall survivability by providing wartime training and exercise support.
 - 13.5.1.2.6. Selectively upgrading minimum quality expedient facilities to standards better capable of supporting sustained wartime operations.
- 13.5.2. Base Recovery. After an attack, engineer efforts will concentrate on restoring air operations in the least possible time. Damage assessment, expedient runway repair throughout the flight line, and emergency war damage repair to utility systems and priority facilities throughout the base complex will be necessary. The working environment will possibly be heavily laden with exploded and unexploded ordnance; contain disrupted utilities (live electrical lines, spewing gas lines, broken water pipes, raw sewage discharge, etc.); be subject to multiple, uncontrolled fires; include damaged facilities, roads and pavements; and possibly be covered with chemical agents. Additionally, there may be many casualties in the damaged areas that must be rescued and attended to before repair efforts can begin in earnest. After the threat of air attack has been minimized, engineers will begin replacing the expedient repairs with more permanent repairs. Repairs to non-priority facilities will be started. Construction management of Air Force construction activities performed by the Army engineers during the permanent rebuild of runways, taxiways, utilities, facilities, and roads will be performed. If, as a last resort, denial operations are required, engineers may be directed to deny the enemy any item that contributes directly to the war effort. These items include military equipment, priority facilities, utilities, runways, taxiways, roads, and items of military intelligence value. Engineer supplies and equipment will be evacuated whenever possible.
- 13.5.3. Levels of Effort. Expedient force beddown, rapid runway repair, and war damage repair are based on a 72-hour work week. All other civil engineer operations and maintenance manpower requirements are based on a 60-hour work week or 10-hour shifts working six days per week. Manpower requirements also include the use of multitasking efforts wherever possible.
- 13.5.4. Crash Rescue and Fire Suppression Manning. Staffing for crash rescue and fire suppression activities is based on the fire protection vehicle requirements. The bare base host MAJCOM will determine the structural vehicle requirements (not to exceed two vehicles), while the bare base assigned aircraft, sortie rate per day, and number of aircraft on the ground will determine crash fire rescue (CFR) vehicle requirements. As a result, additional CFR vehicles above the basic set identified in Allowance Standard 012 may be required. Once total fire protection vehicle requirements are known, staffing requirements can then be identified. Attachment 21 provides the necessary guidance to determine both vehicle and staffing requirements.
- 13.5.5. Factors Affecting the Engineer Force. All the planning covered in this and the preceding chapters of this volume is meaningless unless engineers -- the human factor in the bare base equation -- are capable of operating and surviving under the adverse conditions of a warfighting environment. The following paragraphs are addressed not only to the planner, but also the civil engineer organization as a whole.

13.5.5.1. Training. The success of missions in a theater of operations depends upon the level of individual and unit training. Engineers must train the way they expect to fight. They must train in wartime engineering, construction, operations, and maintenance, because they will all be required. They must train to be innovative, because shortages of supplies, equipment, and men will demand it. Their training must stress flexibility and multiskilling capabilities, because casualties and unforeseen situations will demand the most from them. Engineers must train in contingency engineer skills, as well as their primary and secondary Air Force specialties. Field maneuvers must stimulate their physical and mental limits to build stamina and to minimize the trauma and friction of war should it come to pass. They must train for all conceivable missions in all kinds of weather and climate; they must train for all spectrums of war from military operations other than war to major regional conflicts with chemical, biological, or nuclear considerations. And in preparation for conflicts that will most likely be violent and lethal, engineers must receive, as a minimum, enough combat defense training to give them a reasonable chance of survival. Putting it altogether, engineers must be prepared technically, physically, and psychologically to operate in environments of extreme stress. Finally, the officers and NCOs must train to be leaders in these wartime environments. As leaders, they must be imaginative, innovative, and completely reliable. In summary, engineer proficiency depends on adequate training and professional leadership at all levels of command. In order to meet these energetic and demanding requirements, units must train together at base-level to work as teams. Additionally, every effort must be made to incorporate engineer training scenarios into wing-level training plans and exercises -- to tie engineer wartime response capabilities directly to the operational mission.

13.5.5.2. Survivability. Engineers are vital to sustain forward combat operations. Their support of personnel, equipment, and materials may make the difference between success and failure. Even though engineers play a very limited defensive role, it is imperative they be capable of operating in hostile environments of conventional and chemical ordnance. Engineers must be able to perform the most critical wartime taskings under chemical warfare conditions and be thoroughly knowledgeable of the procedures for wearing the chemical warfare ensemble, accomplishing shelter processing, and responding properly to the various stages of alert. They must be capable of decontaminating limited areas and their own equipment and supply items. They must also be able to repair and service the mechanical and electrical systems supporting personnel shelters, decontamination equipment, and attack warning systems.

13.5.5.2.1. Engineers will be working in areas that could be laden with hundreds of unexploded ordnance items. They must know what to look for, telltale signs of potential danger, and what actions must or must not be taken in the vicinity of unexploded ordnance. They must be able to identify, report, and mark such munitions.

13.5.5.2.2. Engineers may also be subjected to a high volume of direct or indirect fire while engaged in wartime recovery operations. They will likely be enemy targets of opportunity, since damage recovery work assignments and equipment will draw attention and be recognized as essential to sustained air operations. Their work will involve traveling and duties in the less populated areas of the base. Due to the variety and numbers of engineer work assignments, it will not be possible to provide on-scene, full-time armed protection for each work crew. Thus, engineers will be vulnerable to attack by any enemy special operations, saboteur, sniper, or terrorist whose area of influence the engineers happen to enter. Prime BEEF personnel require weapons to defend themselves from such attacks until a security police fire team can arrive to disengage the hostile force, at which time they will pull back; and in some situations, they may be called upon to help defend the air base and should be prepared for that possible eventuality. Their assistance may represent the difference between success or failure at defending an airfield. During conflict, engineers must rely on hardened vehicles, protected positions, deception, withdrawal, personal weapons, and flack vests for survivability.

13.5.5.2.3. Also in the area of survivability, engineers must be prepared to implement dispersal and hardening activities. During beddown of forces, the vulnerability of mobile facility, equipment, and material assets must be considered in terms of the potential enemy threat. If threat conditions warrant, assets should be dispersed within the practical limitations of distance and utility support capabilities. Maximum use of natural cover and camouflage techniques should be made. Hand in hand with dispersal actions are hardening activities. Engineers must be able to perform a wide range of hardening tasks. Revetting of aircraft will be a requirement in almost any contingency of moderate to long duration. Engineers must be capable of single-handedly completing the hardening of most critical base facilities and utility nodes, substations, and plants. They have to be prepared to use any available materials and methods ranging from concrete and metal revetments to earth berms and sandbags.

13.5.5.3. Unit Integrity. Civil engineer Prime BEEF forces deploying with different aircraft squadrons will find themselves assigned to main operating bases and contingency operating locations which include collocated operating bases, standby bases, and bare bases. While mobile Prime BEEF teams are integral to theater in-place forces and responsible to the host

base engineer, they will maintain unit integrity to the fullest extent possible to retain unit cohesion. These forces will maintain their own command, control, and communications; manage the beddown, operations and maintenance, and base recovery activities of their people; plan, coordinate, and supervise their people in both horizontal and vertical construction; provide crash rescue and fire suppression, disaster preparedness, and EOD assistance to in-place forces; and maintain administration and a limited supply capability. During initial beddown and pre-hostility conditions, civil engineer personnel will, in all likelihood, have to contend with unfamiliar beddown locations, shortages of equipment and supplies, extremely compressed timeframes for task accomplishment, and perhaps primitive living and working conditions. Furthermore, the workload will be staggering with many base agencies competing for limited engineer support, each claiming to have the highest priority. During hostilities, Prime BEEF forces will find themselves in periods of conflict and trauma when challenges and dangers prevail. If their air bases are attacked, they will have the responsibility to initiate and orchestrate air base recovery in as short a time as possible to enable the main fighting units to perform their missions. Under such conditions, high morale can make the difference between success and failure. It is cultivated by good leadership, discipline, comradeship, esprit de corps, and devotion to a unit. Together, these qualities -- all inspired through unit integrity -- make people endure and show courage in times of fatigue and danger. In peacetime civil engineer units work as entities performing routine tasks of operations, maintenance, and repair. In a contingency situation, their tasks will be many times more demanding. More rapid response will be needed, fewer people per task will be available, materials will be in short supply, no detailed planning will have been accomplished, the environment will be foreign or perhaps hostile, and there will be no room for error. These situations make the need for cohesion and unity more important than ever. In the final analysis it will be the qualities of unit integrity, and not so much the numbers of engineers and special pieces of equipment, that will count.

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The Civil Engineer

GLOSSARY OF REFERENCES, ABBREVIATIONS, ACRONYMS AND TERMS***References***

AFI 10-209, *RED HORSE Program*

AFI 10-210, *Prime Base Engineer Emergency Force (BEEF) Program (formerly AFR 93-3)*

AFI 32-1026, *Planning and Design of Airfields*

AFI 32-1042, *Standards for Marking Airfields*

AFMAN 32-4005, *Personnel Protection and Attack Actions*

AFJPAM 32-8013, Volume 1, *Planning and Design of Roads, Airfields and Heliports in the Theater of Operations - Road Design*

AFJPAM 32-8013, Volume 2, *Planning and Design of Roads, Airfields and Heliports in the Theater of Operations - Airfield and Heliport Design*

AFPAM 10-219, Volume 6, *Planning and Design: Theater of Operations Air Bases*

AFPAM 10-219, Volume 7, *Expedient Construction Methods*

AFI 10-208, *Continuity of Operations Plans*

AFI 10-211, *Civil Engineer Contingency Response Planning*

AFI 10-403, *Deployment Planning*

AFI 10-404, *Base Support Planning*

AFI 25-101, *War Reserve Materiel (WRM) Program Guidance and Procedures*

AFI 25-201, *Support Agreements Procedures*

AFI 32-3001, *Explosive Ordnance Disposal Program*

AFI 32-4001, *Disaster Preparedness Planning and Operations*

AFI 32-4007, *Camouflage, Concealment and Deception*

AFI 37-101, *War and Contingency Planning*

AFMAN 10-401, *USAF Operation Planning Process*

AFR 93-10, *Troop Construction and Engineering Support of the Air Force Overseas*

Acronyms and Abbreviations

ABD	Air Base Defense
ABS	Air Base Survivability
ac	alternating current

ACH	Aircraft Maintenance Hangar
AF	Air Force
AFB	Air Force Base
AFCESA	Air Force Civil Engineer Support Agency
AFFF	Aqueous Film Forming Foam
AFPAM	Air Force Pamphlet
AFRES	Air Force Reserve
AFS	Air Force Specialty
AGE	Aerospace Ground Equipment
ALCE	Air Lift Control Element
amp	Ampere
ANG	Air National Guard
AO	Area of Operations
ATC	Air Transportable Clinic
ATH	Air Transportable Hospital
AWG	American Wire Gauge
bbl	Barrel
BCE	Base Civil Engineer
BDR	Bomb Damage Repair
BOD	Biochemical Oxygen Demand
BOI	Basic of Issue
BOL	Battery Operated Lights
BPA	Blanket Purchase Agreement
BRAAT	Base Recovery After Attack
Btu	British Thermal Unit
BW	Biological Warfare
C3	Command, Control, and Communications
CCD	Camouflage, Concealment and Deception
CCP	Casualty Collection Point
CDWS	Civil Defense Warning System
CE	Civil Engineer
CESP	Civil Engineering Support Plan
CFR	Crash Fire Rescue
CH	Contingency Hospital
COB	Collocated Operating Base
COMSEC	Communications Security
CONEX	Consolidated Express (Containers)
CONUS	Continental United States
CPG	Conceptual Planning Guide
CPM	Critical Path Method
CRAF	Civil Reserve Air Fleet
CSAF	Chief of Staff, Air Force
CSG	Combat Support Group
CSS	Contingency Support Set
cu ft/sec	Cubic Foot per Second
CW	Chemical Warfare
DAT	Damage Assessment Team
dc	Direct Current
DCC	Damage Control Center
DFP	Defensive Fighting Position
DMA	Defense Mapping Agency
DOD	Department of Defense
DODR	Department of Defense Regulation

DP	Disaster Preparedness
E-G	Electric Generator
EOD	Explosive Ordnance Disposal
EOR	Explosive Ordnance Reconnaissance
ESC	Expandable Shelter Container
EXP	Expandable Personnel Shelter
FEBA	Forward Edge of the Battle Area
FEL	Frontend Loader
FOD	Foreign Object Damage
FOL	Forward Operating Location
gal	gallons
gal/d	gallon per day
gal/m gpm	gallons per minute
GCA	Ground Control Approach
GP	General Purpose
gpd	gallons per person per day
gph	gallons per person per hour
gpm	gallons per person per minute
GPM	General Purpose Medium
h	Hour
HE	Harvest Eagle
HF	Harvest Falcon
hp	horsepower
HTA	High Threat Area
HTHW	High Temperature Hot Water
HTSA	Host-Tenant Support Agreement
HVLT	High Voltage Long-Term
HVST	High Voltage Short-Term
Hz	hertz
IL	Isolating
ILS	Instrument Landing System
IMA	Individual Mobilization Augmentee
IR	Infrared
ISO	International Standardization Organization
ISSA	Interservice Support Agreement
JCS	Joint Chiefs of Staff
JSP	Joint Support Plan
kg/L	kilogram per liter
kV	kilovolt
kVA	kilovoltampere
kVp	kilovolt peak
kW	kilowatt
kWh	kilowatt hour
lat	Latitude
LB	Limited Base
LCN	Load Classification Number
lin ft	linear foot
LN	Local National

LOC	Lines of Communications
LORAN	Long-Range Aid to Navigation
LOX	Liquid Oxygen
LTA	Low Threat Area
LVLT	Low Voltage Long-term
LVST	Low Voltage Short-term
MAAS	Mobile Aircraft Arresting System
MAJCOM	Major Command
MDF	Main Defense Force
MEP	Mission Essential Power
MHE	Materials Handling Equipment
mi	mile
MKT	Mobile Kitchen Trailer
mm	millimeter
MOB	Main Operating Base
MOS	Minimum Operating Strip
mph	miles per hour
MRA	Minimum Reserve Authorization
MSL	Mean Sea Level
MTF	Medical Treatment Facility
NATO	North Atlantic Treaty Organization
NAVAIDS	Navigational Aids
NBC	Nuclear, Biological, and Chemical
NCO	Noncommissioned Officer
NCOIC	Noncommissioned Officer in Charge
NSN	National Stock Number
NTA	Non-Threat Area
OI	Operating Instruction
O&M	Operation and Maintenance
OIC	Officer in Charge
ONC	Operational Navigation Charts
OPLAN	Operation Plan
OPR	Office of Primary Responsibility
OPSEC	Operations Security
OR	Operationally Ready
ORI	Operational Readiness Inspection
OSHA	Occupational Safety and Health Administration
OSI	Office of Special Investigations
PACAF	Pacific Air Forces
PB	Prime BEEF
PDC	Primary Distribution Center
PMEL	Precision Measurement Equipment Laboratory
POL	Petroleum, Oils and Lubricants
ppm	parts per million
Prime BEEF	Prime Base Engineer Emergency Force
psi	Pounds per Square Inch
RAL	Remote Area Lighting
RAPCON	Radar Approach Control
RCR	Runway Condition Reading
RED HORSE	Rapid Engineer Deployable Heavy Operational Repair Squadron, Engineer
ROK	Republic of Korea

ROWPU	Reverse Osmosis Water Purification Unit
RRR	Rapid Runway Repair
RSC	Runway Surface Condition
RSP	Render-safe Procedures
SAR	Search and Rescue
SBSS	Standard Base Supply System
SCNS	Standard Camouflage Net System
SDC	Secondary Distribution Center
SME	Squadron Medical Element
SNCOIC	Senior NCOIC
SOA	Separate Operating Agency
SOF	Special Operations Forces
SP	Security Police
SRC	Survival Recovery Center
STAMP	Standard Air Munitions Package
STANAG	Standard NATO Agreement
SWA	Southwest Asia
TACAN	Tactical Air Navigation
TDS	Total Dissolved Solids
TDY	Temporary Duty
TEMPER	Tent Extendable Modular Personnel
TLV	Threshold Limit Value
TM	Technical Manual
TO	Technical Order
TOL	Takeoff and Landing
TPFDD	Time-Phased Force and Deployment Data
TPFDL	Time-Phased Force and Deployment List
UMD	Unit Manning Document
US	United States (of America)
USAF	United States Air Force
USAFE	United States Air Forces in Europe
UTC	Unit Type Code
UXO	Unexploded Ordnance
V	Volt
VA	voltampere
VAC	volts alternating current
VAL	Vehicle Authorization List
VASI	Visual Approach Slope Indicator
VDC	volts direct current
W	Watt
WDR	War Damage Repair
WMP	War and Mobilization Plan
WOC	Wing Operations Center
WRM	War Reserve Materiel
WSK	War Readiness Spares Kit

Terms

Air Base Defense--Those measures taken to nullify or reduce the effectiveness of enemy attacks on, or sabotage of, air bases to ensure that the senior commander retains the capability to assure aircraft sortie generation.

Air Force Civil Engineer Support Agency (AFCESA)--A field operating agency (FOA) located at Tyndall Air Force Base, Florida. The Directorate of Contingency Support (HQ AFCESA/CEX) acts as the Air Force program manager for Base Civil Engineer (BCE) Contingency Response Planning.

Area of Operations--An operational area defined by the joint force commander for land and naval forces. Areas of operation do not typically encompass the entire operational area of the joint force commander, but should be large enough for component commanders to accomplish their missions and protect their forces.

Arresting Sheave Span--The distance across the runway between sheaves of an aircraft arresting system.

Arresting System Reset Time--The time required to make the arresting system ready for another engagement from the beginning of reset.

Bare Base--A base having minimum essential facilities to house, sustain, and support operations to include, if required, a stabilized runway, taxiways, and aircraft parking areas. A bare base must have a source of water that can be made potable. Other requirements to operate under bare base conditions form a necessary part of the force package deployed to the bare base.

Base Denial--The destruction or denial of vital air base resources so the enemy cannot use them against friendly forces or for his benefit.

Base Development--The improvement or expansion of the resources and facilities of an area or a location to support military operations.

Base Recovery After Attack (BRAAT)--A theater concept of recovering a base after conventional attack where resumption of flying operations is the first priority. Other recovery activities may be conducted concurrently; however, these activities must not impede the resumption of flying operations.

Camouflage, Concealment, and Deception--The use of concealment, disguise and decoys to minimize the possibility of detection or identification of troops, material, equipment and installations. It includes taking advantage of the natural environment as well as the application of natural and artificial materials.

Camouflet--The resulting cavity in a deep underground burst when there is no rupture of the surface.

Cannibalize--To remove serviceable parts from one item of equipment in order to install them on another item of equipment.

Caretaker Status--A nonoperating condition in which the installations, materiel and facilities are in a care and limited preservation status. Only a minimum of personnel is required to safeguard against fire, theft, and damage from the elements.

Chemical Defense--The methods, plans and procedures involved in establishing and executing defensive measures against attack utilizing chemical agents.

Chemical Warfare--All aspects of military operations involving the employment of lethal and incapacitating munitions/agents and the warning and protective measures associated with such offensive operations. Since riot control agents and herbicides are not considered to be chemical warfare agents, those two items will be referred to separately or under the broader term "chemical", which will be used to include all types of chemical munitions/agents collectively. The term "chemical warfare weapons" may be used when it is desired to reflect both lethal and incapacitating munitions/agents of either chemical or biological origin.

Collocated Operating Base (COB)--An active or Reserve allied airfield designated for joint or unilateral use by US Air Force wartime augmentation forces or for wartime relocation of US Air Force in-theater forces. COBs are not US bases.

Command and Control--The exercise of authority and direction by a properly designated commander over assigned and attached forces in the accomplishment of the mission. Command and control functions are performed through an arrangement of personnel, equipment, communications, facilities, and procedures employed by a commander in planning, directing, coordinating, and controlling forces and operations in the accomplishment of the mission.

Continental United States (CONUS)--United States territory, including the adjacent territorial waters, located within North

America between Canada and Mexico.

Contingency--An emergency involving military forces caused by natural disasters, terrorists, subversives, or by required military operations. Due to the uncertainty of the situation, contingencies require plans, rapid response, and special procedures to ensure the safety and readiness of personnel, installations, and equipment.

Contingency Plan--A plan for major contingencies that can reasonably be anticipated in the principal geographic subareas of the command.

Contingency Response Plan--A base civil engineer plan of action developed in anticipation of all types of contingencies, emergencies, and disasters.

Conventional Weapons --A weapon which is neither nuclear, biological, nor chemical.

Convoy--A group of vehicles organized for the purpose of control and orderly movement with or without escort protection.

Counterterrorism--Offensive measures taken to prevent, deter, and respond to terrorism.

Decontamination--The process of making any person, object, or area safe by absorbing, destroying, neutralizing, making harmless, or removing, chemical or biological agents, or by removing radioactive material clinging to or around it.

Deploy--To relocate a unit, or an element thereof, to a desired area of operations or to a staging area. Deployment will be accomplished with all required personnel and equipment. Deployment begins when the first aircraft, personnel, or item of equipment leaves the home base. The force is deployed when the last component of the unit has arrived.

Disaster Control--Measures taken before, during or after hostile action or natural or man-made disasters to reduce the probability of damage, minimize its effects, and initiate recovery.

Dispersal--Relocation of forces for the purpose of increasing survivability.

Dispersal Airfield--An airfield, military or civil, to which aircraft might move before H-hour on either a temporary duty or permanent change of station basis and be able to conduct operations.

Domestic Sewage--The waste from toilets, lavatories, urinals, bath tubs, showers, laundries, and kitchens.

Engineer Damage Assessment--The process of identifying and locating damage and unexploded ordnance following an enemy attack. Damage assessment activities are generally separated into two categories--RRR and facility.

Exercise--A military maneuver or simulated wartime operation involving planning, preparation, and execution. It is carried out for the purpose of training and evaluation. It may be a combined, joint, or single-Service exercise, depending on participating organizations.

Explosive Ordnance Disposal (EOD)--The detection, identification, on-site evaluation, rendering-safe, recovery and final disposal of unexploded explosive ordnance. It may also include explosive ordnance which has become hazardous by damage or deterioration.

Explosive Ordnance Reconnaissance (EOR)--Reconnaissance involving the investigation, detection, location, marking, initial identification and reporting of suspected unexploded explosive ordnance, by explosive ordnance reconnaissance agents, in order to determine further action.

Facility--Any structure, pavement, or utility system which supports Air Force operations.

Field of Fire--The area which a weapon or a group of weapons may cover effectively with fire from a given position.

Force Beddown--The provision of expedient facilities for troop support to provide a platform for the projection of force. These facilities may include modular or kit-type substitutes.

Foreign Object Damage (FOD)--Rags, pieces of paper, line, articles of clothing, nuts, bolts, or tools that, when misplaced or caught by air currents normally found around aircraft operations (jet blast, rotor or prop wash, engine intake), cause damage to aircraft systems or weapons or injury to personnel.

Forward Operating Base--An airfield used to support tactical operations without establishing full support facilities. The base may be used for an extended time period. Support by a main operating base will be required to provide backup support for a forward operating base.

Harvest Eagle--A nickname for an air transportable package of housekeeping equipment, spare parts, and supplies required for support of US Air Force general-purpose forces and personnel in bare base conditions. Examples of Harvest Eagle equipment are water purification units, tents, and showers. Each kit is designed to provide softwall housekeeping support for 1100 personnel.

Harvest Falcon--Harvest Falcon is a nickname given to a selected package of mobile facility, utility and equipment assets required to support forces and aircraft under bare base conditions. These WRM assets are packaged in air transportable sets to include housekeeping, industrial, initial flightline and follow-on flightline. Harvest Falcon sets are designed to support increments of 1,100 personnel and squadron size aircraft deployments.

High Threat Area--An area which, because of its location or strategic targets, is highly susceptible to enemy attacks.

Joint Support Plan (JSP)--A plan for the reception and beddown of forces which is collectively developed by the host nation, the theater in-place sponsor, and the affected augmentation unit. The plan outlines all facets of operations at a collocated operating base to include personnel, facilities, and equipment.

Key Terrain--Any locality, or area, the seizure or retention of which affords a marked advantage to either combatant.

Limited Base (LB)--A base that is austere manned and normally has no permanently assigned operational tactical forces, but may possess a small force for special operations (weather surveillance, alert aircraft, special purpose aircraft, etc.). With personnel augmentation, this base is capable of receiving deployed forces. It may have facilities for communications, air traffic control, navigational aids, maintenance, base supply, munitions, weather, medical services, billeting, messing, transportation, and operational support. It may or may not be supported in peacetime as a satellite of a main base. War reserve materiel, including petroleum, oils, and lubricants (POL), may be maintained in a state of readiness for use by the deploying force to initiate and sustain operations.

Limiting Factor--A factor or condition that, either temporarily or permanently, impedes mission accomplishment. Illustrative examples are transportation network deficiencies, lack of in-place facilities, and malpositioned forces or materiel, extreme climatic conditions, distance, transit or overflight rights, political conditions, etc.

Main Operating Base (MOB)--A base on which all essential buildings and facilities are erected. Total organizational and intermediate maintenance capability exists for assigned weapon systems. The intermediate maintenance capability may be expanded to support specific weapon systems deployed to the MOB.

Minimum Operating Strip (MOS) Selection--The process of plotting damage and unexploded ordnance (UXO) locations on a map of the air base runway and using this information to select a portion of the damaged runway which can be most quickly repaired to support aircraft operations.

Mobility--A quality or capability of military forces which permits them to move from place to place while retaining the ability to fulfill their primary mission.

Mutual Support--That support which units render each other against any enemy, because of their assigned tasks, their position relative to each other and to the enemy, and their inherent capabilities.

Nuclear, Biological and Chemical (NBC) Defense--The methods, plans, procedures and training required to establish defense measures against the effects of attack by nuclear weapons, chemical and biological agents.

Operation Plan--Any plan, except for the Single Integrated Operation Plan, for the conduct of military operations. Plans are

prepared by combatant commanders in response to requirements established by the Chairman of the Joint Chiefs of Staff and by commanders of subordinate commands in response to requirements tasked by the establishing unified commander. Operation plans are prepared in either a complete format (OPLAN) or as a concept plan (CONPLAN). The CONPLAN can be published with or without a time-phased force and deployment data (TPFDD) file. a. OPLAN--An operation plan for the conduct of joint operations that can be used as a basis for development of an operation order (OPORD). An OPLAN identifies the forces and supplies required to execute the CINC's strategic concept and a movement schedule of these resources to the theater of operations. The forces and supplies are identified in TPFDD files. OPLANs will include all phases of the tasked operation. The plan is prepared with the appropriate annexes, appendixes, and TPFDD files as described in the Joint Operation Planning and Execution System manuals containing planning policies, procedures, and formats. b. CONPLAN--An operation plan in an abbreviated format that would require considerable expansion or alteration to convert it into an OPLAN or OPORD. A CONPLAN contains the CINC's strategic concept and those annexes and appendixes deemed necessary by the combatant commander to complete planning. Generally, detailed support requirements are not calculated and TPFDD files are not prepared. c. CONPLAN with TPFDD--A CONPLAN with TPFDD is the same as a CONPLAN except that it requires more detailed planning for phased deployment of forces.

Potable Water--Water which is safe for consumption.

Primary Circuit--An electrical circuit carrying greater than 600 volts.

Prime BEEF (Base Engineer Emergency Forces)--A Headquarters US Air Force, major command (MAJCOM), and base-level program that organizes civil engineer forces for worldwide direct and indirect combat support roles. It assigns civilian employees and military personnel to both peacetime real property maintenance and wartime engineering functions.

Rapid Runway Repair (RRR)--The process of using construction equipment, tools, portable equipment, expendable supplies, and temporary surfacing materials to provide a minimum operating surface through expedient repair methods.

RED HORSE--Squadrons established to provide the Air Force with a highly mobile, self-sufficient, rapidly deployable civil engineering capability required in a potential theater of operations.

Retrograde Movement--Any movement of a command to the rear, or away from the enemy. It may be forced by the enemy or may be made voluntarily. Such movements may be classified as withdrawal, retirement, or delaying action.

Reverse Osmosis Water Purification Unit (ROWPU)--A water purification device which uses a series of membranes to eliminate impurities. The ROWPU is capable of removing dissolved minerals.

Sanitary Sewer--A sewage system which carries only domestic sewage.

Secondary Circuit--An electrical circuit carrying less than 600 volts.

Standardization Agreement (NATO)--The record of an agreement among several or all of the member nations to adopt like or similar military equipment, ammunition, supplies and stores; and operational, logistic, and administrative procedures. National acceptance of a NATO allied publication issued by the Military Agency for Standardization may be recorded as a Standardization Agreement (STANAG).

Standby Base (SB)--An austere base designated for wartime use having adequate airfield facilities to accept deployed aircraft. An SB is maintained in a caretaker status until it is fully augmented, at which time it is capable of receiving and employing assigned aircraft. To initiate and sustain operations, all supporting personnel, supplies, and equipment must be provided. Petroleum, oils, lubricants (POL), and munitions may be prepositioned in a state of readiness for use by the deploying forces.

Standoff--A steel or wood curtain erected approximately 10 feet in front of a protective structure to detonate shells and thereby reduce the penetrating effect.

Storm Sewage--The inflow of surface runoff during or immediately following a storm or heavy rain.

Subversion--Action designed to undermine the military, economic, psychological, morale, or political strength or morale of a regime.

Survivability--Capability of a system to accomplish its mission in the face of an unnatural (man-made) hostile, scenario-dependent environment. Survivability may be achieved by avoidance, hardness, proliferation, or reconstitution (or a combination).

Survival Recovery Center (SRC)--A supplemental command post that is collocated with, or immediately adjacent to the wing command post to ensure expeditious resumption of flying operations after attack. The Combat Support Group commander directs operations of the SRC. The base civil engineer is a member of the SRC staff.

Time-Phased Force and Deployment List (TPFDL)--Appendix 1 to Annex A of the operation plan. It identifies types and/or actual units required to support the operation plan and indicates origin and ports of debarkation or ocean area. It may also be generated as a computer listing from the time-phased force and deployment data.

Unimproved Surface--A takeoff and landing (TOL) surface that has not been improved through paving with asphalt, concrete, or other durable substance. For example, a grass or dirt landing strip.

Unit Type Code (UTC)--A five-character alphanumeric code that uniquely identifies each type unit of the Armed Forces.

War and Mobilization Plan (WMP)--The Air Force supporting plan to the Joint Strategic Capabilities Plan. The six volumes of the WMP extend through the Future Years Defense Program to provide continuity in short- and mid-range war and mobilization planning. It provides current planning cycle policies and planning factors for the conduct and support of wartime operations. It establishes requirements for development of mobilization and production planning programs to support sustained contingency operations of the programmed forces. The WMP encompasses all functions necessary to match facilities, manpower, and materiel with planned wartime activity."

War Damage Repair (WDR)--The repair of all facilities except airfield pavements.

War Reserve Materiel (WRM)--Materiel required in addition to primary operating stocks and mobility equipment to attain the operational objectives in the scenarios authorized for sustainability planning in the Defense Planning Guidance. Broad categories are: consumables associated with sortie generation (to include munitions, aircraft external fuel tanks, racks, adapters, and pylons); vehicles; 463L systems; materiel handling equipment; aircraft engines; bare base assets; individual clothing and equipment; munitions and subsistence.

PLANNING FACTORS

FACILITY CATEGORY CODE	DESCRIPTION	PLANNING FACTORS
111A	Runway, Fixed Wing	See Volume 6
111B	Runway, Rotary Wing	3,000 SY
111C	Helicopter Landing Pad	1,100 SY per pad
112A	Taxiways	Planner analysis (Width Criteria: rear area--60 ft; support area--60 ft for cargo aircraft (AC), 50 ft for tactical AC; regardless of area, use 75 ft for C5A AC, 75 ft with 50 ft stabilized shoulders each side for B-52 AC and 50 ft with 25 ft stabilized shoulders each side for KC/RC-135 and KC-10 AC). See Volume 6
113A	Aircraft Parking Apron	
116A	Aircraft Wash Rack	See Table A2.1
116B	Compass Calibration Pad	800 SY per AB (Tactical AC)
116C	Arm/Disarm Pad	1,600 SY per AB
116D	Holding Pad (Ordnance)	14,900 SY per AB
121A	AC Fuel Dispensing	17,800 SY per Aerial Port of Debarkation (APOD) 4,230 SY per non-APOD
121B	AC Truck Fuel Facility	One outlet per three bomber/cargo type AC
123A	Land Vehicle Fuel Dispensing	
124A	A/C Operating Fuel	4 outlets per AB
124C	Land Vehicle Operating Fuel Storage	1 outlet per 100 vehicles
125A	POL Pipeline	Classified, See Fuels Planner
125B	POL Pipeline Facility	Requirement included in 411D
131A	Communications Center	Planner Analysis
131B	Receiver Building	Planner Analysis
131D	Transmitter Building	8,100 SF per Base
131E	Communications Buildings, Other	Planner Analysis Planner Analysis Planner Analysis

***In some cases, Harvest Falcon and Harvest Eagle assets may provide significantly less square footage than indicated by these planning factors. Do not expect additional assets to arrive to make up differences.**

FACILITY CATEGORY CODE	DESCRIPTION	PLANNING FACTORS
133A	Control Tower	1 ea per AB
136A	A/F Pavement Lighting	Planner Analysis
141B	Explosive Ordnance Disposal (EOD) Facility	960 SF per Base
141D	AC Shelter, Hardened	Required for 70 percent (100 percent desired) of the AC of Fighter/RECCE units
141E	Squadron Air Operations Facility	See Table A2.2
141H	Cryogenic Facility	2,400 SF per AB per 1.5 Ton Plant, 4,800 SF per AB per 5 Ton Plant
141I	POL Operations/Laboratory Facility	2,750 SF per AB
141K	Photo Laboratory	3,000 SF per RECCE Squadron (18 PAA)
141L	Base/Airfield Operations Facility	
141M	Air Freight Terminal	5,055 SF per AB
141N	Air Passenger Terminal	175 SF/Short Ton Throughput (4,000 SF per Base Minimum)
141P	Command Post	2,000 SF per AB
141Q	AC Hardened Shelter Door	Planner Analysis
149A	AC Revetment	Planner Analysis
149B	AC Arresting Barrier	Revet all Fighter, Tactical Airlift, Bomber, and RECCE AC not otherwise protected
149C	Bunker, Defensive Position	One system per runway
149E	Structure Revetment	As required (Security Police Units only)
211A	AC Maintenance Hangar	6,000 Linear Feet (LF) per Main Operating Base; 3,000 LF per Collocated Operating Base
211B	Reclamation Shop	
211C	AC Weapons Calibration	See Table A2.3
211D	AC Organizational Maintenance Shop	1,000 SF per AB
211E	AC Engine Repair Shop	6,000 SF per Fighter/RECCE AB

FACILITY CATEGORY CODE	DESCRIPTION	PLANNING FACTORS
211F	General Purpose AC Maintenance Shop	See Table A2.4
214B	Auto Vehicle Shop	7,500 SF per AB See Table A2.5 12,000 SF per Base
214C	Refueler Shop	2,700 SF per Base
215A	Maintenance Weapons	8,625 SF per Base
216A	Maintenance Ammunition	7,570 SF per Base
217A	Communication/Electronics Shop	Planner Analysis
217B	Avionics Shop	See Table A2.6
218C	Ground Support Equipment Shop	125 SF per Aircraft plus 3,880 SF per Main Operating Base
218D	Parachute/Dinghy Maintenance Shop	6,065 SF per AB
219A	Base Facilities Maintenance	3.25 SF per man
411B	AVGAS Storage	Classified, See Fuels Planner
411C	Diesel Storage	0.1 BBL/Man/Day x Population Supported = BBLs/DOS.
411D	MOGAS Storage	0.1 BBL/Man/Day x Population Supported = BBLs/DOS.
411E	JP Storage	Classified, See Fuels Planner
411G	Demineralized Water	2 each 600 GAL/Hour Unit for each Base Supporting F111, B-52 or KC 135 Units
421A	Ammunition Covered Storage	Classified, See Munitions Planner
425A	Ammunition Open Storage	Classified, See Munitions Planner
431A	Depot Cold Storage	0.2429 CF/Man x DOS x Men Supported = CF
432A	Installation Cold Storage	0.7 CF per Man
441A	Depot Covered Storage	0.0419 SF/Man x DOS x Men Supported = SF
442A	Installation Covered Storage	3.70 SF per Man, 380 SF per Fighter AC, 540 SF per Airlift AC
451A	Depot Open Storage	

FACILITY CATEGORY CODE	DESCRIPTION	PLANNING FACTORS
452A	Installation Open Storage	<p>0.0140 SY/Man x DOS x Men Supported = SY</p> <p>0.67 SY per Man, 1,500 SY per Base, 12 SY per Fighter AC, 24 SY per Airlift AC</p>
510A	In-Patient Facility	Based on Analysis of Medical Units
540A	Dental Facility	Based on Analysis of Medical Units
550A	Out-Patient Facility	Based on Analysis of Medical Units
610A	Administration Facility	60 SF per Man
610B	Operations/Logistic Computer Facility	Planner Analysis
721A	Troop Housing, Enlisted	72 SF per EM
722A	Dining Facility	14 SF per Man
724A	Troop Housing, Officer	100 SF per Officer
725A	Emergency Troop Housing	50 SF per Man
725B	Emergency Troop Messing	9 SF per Man
730A	A/C and Installation Fire Station	6,000 SF per Base
730B	Military Police/Brig Facility	9,700 SF per Base
811A	Electricity Source	2.7 kW per Man
812A	Electrical Distribution Line	50 LF per Man
812H	Heating Plant	Planner Analysis
831A	Sewage Treatment	14.0 Gal/Man
832A	Sewage Collection	10.0 LF/Man
841A	Water Source	<p>50 Gal/Man/Day when using non-mobile assets</p> <p>20 Gal/Man/Day when using mobile water system assets</p>
841B	Water Treatment	<p>50 Gal/Man/Day when using non-mobile assets</p> <p>20 Gal/Man/Day when using mobile water system assets</p>

FACILITY CATEGORY CODE	DESCRIPTION	PLANNING FACTORS
841C	Water Storage	
842A	Water Distribution Line	250/Gal/Man (100 Gal/Man for SWA)
851A	Roads	11 LF/Man
872A	Fencing	Planner Analysis
		Planner Analysis

Table A2.1. Parking Apron Per Aircraft.				
AIRCRAFT ¹	WING	LENGTH	FACTOR	APRON(SF)
C-5	222.7	247.8	3.5	193147.7
F-16	32.8	47.6	4.4	6869.6
F-15	42.8	63.8	4.4	12014.8
F-117	43.3	65.1	4.4	12402.8
F-111	63.0	73.5	4.4	20374.2
FB-111	70.0	75.5	4.4	23254.0
A-10	57.5	53.3	4.4	13484.9
E3	145.7	152.9	3.5	77971.4
HH53	72.3	88.3	9.2	58733.6
HH60	53.7	64.9	9.2	32063.2
KC-135	130.8	136.2	3.5	62352.4
C-130	132.6	99.5	3.5	46177.9
C-141	160.6	168.4	3.5	94304.0
ABCCC	132.6	97.7	3.5	45342.6
KC-10	165.3	182.1	3.5	105353.9
JSTARS	145.9	152.9	3.5	78078.4
RF4	38.4	63.0	4.4	10644.5
C-17	170.0	175.2	3.5	104244.0
¹ Dimensions vary for different models and configurations of aircraft.				

Table A2.2. Space Requirements for Squadron Operations.				
MISSION	REQUIRED SQ. FEET	NUMBER OF AIRCRAFT	SQ. FEET PER AIRCRAFT	AIRCRAFT TYPES
Tactical Fighter Bomber	5,800	24	242	A-10, FB-111
Air Rescue	5,800	15	387	HC-130, MH60
Tactical Airlift	11,520	16	720	C-23, C-7, C-130
Strategic Airlift	12,000	18	467	C-5, C-141, C-17
Tactical Fighter (1 place)	9,000	24	375	F-15, F-16, F-117
Tactical Fighter (F-111)	12,500	24	521	F-111
Heavy Bomber	12,900	16	806	B-52, B-1
Tanker	9,600	15	640	KC-135, KC 10
Tactical Recon	10,980	18	610	RF-4
Tactical Support	9,000	24	375	E-3, MH53, OA-10
Strategic Recon	2,700	2	1,350	RC-135, U-2

Table 2.3. Principles Application Effects.				
FACILITY DESCRIPTION	PLANNING FACTOR	BASIC REQUIREMENT	PRINCIPLES APPLIED	EFFECT
Squadron Ops	9,000 SF/TFS	18,000 SF	Protect Resources Redundancy Accessibility Reliability Plan for People	Revetments Siting CCD Backup Power Air Cond/Vent Dispersal
Aircraft Revet	1/Ftr Acft	36 ea.	Protect Resources	N/A
Elect Power	2.7 kW/Per	5940 kW	Redundancy Resiliency Sustainability Interoperability Protect Resources Reliability	Backup Power Protection On-Site Fuel Storage Dispersal Revet/CCD Fencing/Berm
Troop Hsg	50 SF/Per	110,000 SF	Plan for People Protect Resources	Siting Air Condition Dispersal Revetment
Base Operations	5,055 SF/AB	5,055 SF	Protect Resources Reliability	Revetment Backup Power CCD

Table A2.4. Category Code 211D, Aircraft Organizational Maintenance Shop.				
Air Force requirements for organizational maintenance shop by mission and aircraft type are as follows:				
MISSION	AREA SQUARE FT	NUMBER OF AIRCRAFT	SQUARE FT/ AIRCRAFT	AIRCRAFT TYPES
Strategic Airlift Squadron	13,800	18	767	C-5, C-141, C-17
Tactical Airlift Squadron	8,200	16	513	C-7, C-130, C-23
Air Rescue Squadron	5,700	15	380	HH/UH-1, HH-3, MH-53, HC-130, MH-60
Tactical Fighter Squadron	10,000	24	417	A-10, F-15, F-16, F-111, F-117
Tactical Recon Squadron	5,700	18	317	RF-4, EF-111
Tactical Support Squadron	5,700	24	238	EC-130, CH-3, MH-53, E-3, OA-10

Table A2.5. Category Code 211F, General Purpose Aircraft Maintenance Shop.				
Air Force requirements for general purpose aircraft maintenance shop are as follows:				
MISSION	AREA SQUARE FT	NUMBER OF AIRCRAFT	SQUARE FT/ AIRCRAFT	AIRCRAFT TYPES
Tactical Fighter Wing	34,000	72	472	A-10, F-15, F-16, F-111, F-117
Tactical Recon Wing	34,000	54	630	RF-4, RF-111
Tactical Airlift Wing	39,000	48	812	C-7, C-130, C-23
Heavy Bomb Squadron	48,000	16	3,000	B-52, B-1
Tanker Squadron	24,000	15	1,600	KC-135, KC-10
Strategic Airlift Wing	80,000	54	1,481	C-5, C-141, C-17
Tactical Support Squadron	7,840	24	327	CH-3, E-3, OA-10, MH-53, EC-130
Strategic Recon Wing	15,000	2	7,500	RC-135, U-2

Table A2.6. Category Code 217D, Avionics Shop.				
Air Force requirements for avionics shops by mission and aircraft type are as follows:				
MISSION	AREA SQUARE FT	NUMBER OF AIRCRAFT	SQUARE FT/ AIRCRAFT	AIRCRAFT TYPES
1 Tactical Fighter Wing	17,000	72	236	A-10, F-15, F-16, F-111, F-117
1 Tactical Reconnaissance Wing	22,000	54	408	RF-4
1 Tactical Airlift Wing	10,000	48	208	C-7, C-130
1 Tactical Support Squadron	3,360	18	187	OA-10
1 Strategic Airlift Wing	30,000	54	556	C-141, C-5, C-17

TYPE B-1 REVETMENT KIT BILL OF MATERIALS

Type B-1 Kit (16' High X 6'-11" Wide X 252 Linear Feet) List of Items.							
PKG. NO.	ITEM	DWG ITEM NO.	DESCRIPTION	WT/ PC (lbs)	PCS/ PKG	TOTAL QTY	SPARES
1,2,& 3 of 16	Side Panel	SP123	.0486" x 12'-1 1/2" x 36"	103	34	168	NONE
4 & 5 of 16	Side Panel	SP123	.0486" x 12'-1 1/2" x 36"	103	33		
6 & 7 of 16	Side Panel	SP122	.0606" x 12'-1 1/2" x 36"	84	42	84	NONE
8,9,10 & 11 of 16	Cross Panel	CP73	.0486" x 6'-10 1/2" x 36"	58	54	216	NONE
12 & 13 of 16	Cross Panel	CP72	.0606" x 6'-10 1/2" x 24"	48	54	108	NONE
14 of 16	End Cross Panel	CP73E	.0486" x 6'-10 1/2" x 36"	48	48	48	NONE
14 of 16	End Brace Panel	BP43	.0486" x 4'-1 1/4" x 36"	24	24	24	NONE
15 of 16	End Cross Panel	CP72E	.0606" x 6'-10 1/2" x 24"	24	24	24	NONE
15 of 16	End Brace Panel	BP42	.0606" x 4'-1 1/4" x 24"	12	12	12	NONE
16 of 16	Connecting Pin	CP3	1/4" Dia. x 34 7/8"	.53	638	576	62
16 of 16	Connecting Pin	CP2	1/4" Dia. x 23 7/8"	.35	320	288	32
16 of 16	Flaring Tool	-	--	3.5	3	3	NONE
16 of 16	Polyethylene Film	-	.006" x 48" x 300'	35	1 Roll	1 Roll	None
16 of 16	Erection Manual	-	--	-	2	2	NONE

Package Weights and Cubes		
Package No.	Weight/Package (lbs.)	Cubic Ft./Package
1,2,3	3,510	60.8
4,5	3,405	59.7
6,7	3,540	58.2
8,9,10,11	3,150	51.9
12,13	2,600	40.5
14	2,900	66.9
15	720	28.9
16	550	7.2

Kit Weights and Cubes				
Total Package/Kit	Total Shipping Wt/Kit (lbs)	Total Cubic Ft/Kit	No. of PCS/Kit	Spares/Kit
16	46,390	809.8	1,554	94

ELECTRICAL CURRENT CHARACTERISTICS IN SWA

Country and City	Type and Frequency of Current	Number of Phases	Nominal Voltage	Number of Wires	Frequency Stable Enough for Electric Clocks
Afghanistan	a.c.60	1,3	220/380	2,4	Yes
Charikar	a.c.50	1,3	220/380	2,4	Yes
Farah	a.c.50	1,3	220/380	2,4	Yes
Ghazni	a.c.50	1,3	220/380	2,4	Yes
Gulbahar	a.c.50	1,3	220/380	2,4	Yes
Herat	a.c.50	1,3	220/380	2,4	Yes
Jalalabad	a.c.50	1,3	220/380	2,4	Yes
Kabul	a.c.50	1,3	220/380	2,4	Yes
Kandshar	a.c.50	1,3	220/380	2,4	Yes
Kunduz	a.c.50	1,3	220/380	2,4	Yes
Maimana	a.c.50	1,3	220/380	2,4	Yes
Mazar-i-Sharif	a.c.50	1,3	220/380	2,4	Yes
Paghman	a.c.50	1,3	220/380	2,4	Yes
Pul-i-Khumri					
Egypt					
Alexandria	a.c.50	1	110	2	No
Asyut	a.c.50	1,3	220/380	2,3,4	No
Aswan	a.c.50	1,3	220/380	2,3,4	No
Benha	a.c.50	1,3	220/380	2,3,4	No
Beni Suef	a.c.50	1,3	220/380	2,3,4	No
Cairo	a.c.50	1,3	220/380	2,3,4	No
Damanhur	a.c.50	1,3	220/380	2,3,4	No
Damietta	a.c.50	1,3	220/380	2,3,4	No
Heliopolia	a.c.50	1	110	2	No
		1,3	220/380	2,3,4	No
Helwan	a.c.50	1,3	220/380	2,3,4	No
Ismaila	a.c.50	1,3	220/380	2,3,4	No
Dafr el Zaiyat	a.c.50	1,3	220/380	2,3,4	No
Kena	a.c.50	1,3	220/380	2,3,4	No

Country and City	Type and Frequency of Current	Number of Phases	Nominal Voltage	Number of Wires	Frequency Stable Enough for Electric Clocks
Luxor	a.c.50	1,3	220/380	2,3,4	No
El Maadi	a.c.50	1,3	220/380	2,3,4	No
El Mansura	a.c.50	1,3	220/380	2,3,4	No
El Mahalla	a.c.50	1,3	220/380	2,3,4	No
Minia	a.c.50	1,3	220/380	2,3,4	No
Port Fouad	a.c.50	1,3	220/380	2,3,4	No
Port Said	a.c.50	1,3	220/380	2,3,4	No
Port Tewik	a.c.50	1,3	220/380	2,3,4	No
Sohag	a.c.50	1,3	220/380	2,3,4	No
Suez	a.c.50	1,3	220/380	2,3,4	No
Tanta	a.c.50	1,3	220/380	2,3,4	No
Zagazig	a.c.50	1,3	220/380	2,3,4	No
Iran	a.c.50	1,3	220/380	2,3,4	Yes
Abadan	a.c.50	1,3	220/380	2,3,4	Yes
Ahwaz	a.c.50	1,3	220/380	2,3,4	Yes
Behshahr	a.c.50	1,3	220/380	2,3,4	Yes
Ghazvin	a.c.50	1,3	220/380	2,3,4	Yes
Hamadan	a.c.50	1,3	220/380	2,3,4	Yes
Isfahan	a.c.50	1,3	220/380	2,3,4	Yes
Karaj	a.c.50	1,3	220/380	2,3,4	Yes
Kashan	a.c.50	1,3	220/380	2,3,4	Yes
Kerman	a.c.50	1,3	220/380	2,3,4	Yes
Kermanshah	a.c.50	1,3	220/380	2,3,4	Yes
Khorramshahr	a.c.50	1,3	220/380	2,3,4	Yes
Masjed Soleyman	a.c.50	1,3	220/380	2,3,4	Yes
Meshed	a.c.50	1,3	220/380	2,3,4	Yes
Pahlevi	a.c.50	1,3	220/380	2,3,4	Yes
Qom	a.c.50	1,3	220/380	2,3,4	Yes
Resht	a.c.50	1,3	220/380	2,3,4	Yes
Rezaiyeh	a.c.50	1,3	220/380	2,3,4	Yes
Shiraz	a.c.50	1,3	220/380	2,3,4	Yes
Tabriz	a.c.50	1,3	220/380	2,3,4	Yes
Tehran	a.c.50	1,3	220/380	2,3,4	Yes
Yazd	a.c.50	1,3	220/380	2,3,4	Yes

Country and City	Type and Frequency of Current	Number of Phases	Nominal Voltage	Number of Wires	Frequency Stable Enough for Electric Clocks
Iraq (Note 1)					
Baghdad	a.c.50	1,3	220/380	2,4	Yes
Basra	a.c.50	1,3	220/380	2,4	Yes
Kirkuk	a.c.50	1,3	220/380	2,4	Yes
Mosul	a.c.50	1,3	220/380	2,4	Yes
Israel (Notes 1 & 2)					
Beer Sheba	a.c.50	1,3	220/380	2,4	Yes
Haifa	a.c.50	1,3	220/380	2,4	Yes
Holon	a.c.50	1,3	220/380	2,4	Yes
Natanya	a.c.50	1,3	220/380	2,4	Yes
Petah Tiqva	a.c.50	1,3	220/380	2,4	Yes
Ramat-Gan	a.c.50	1,3	220/380	2,4	Yes
Rehovot	a.c.50	1,3	220/380	2,4	Yes
Tel Aviv	a.c.50	1,3	220/380	2,4	Yes
Jerusalem	a.c.50	1,3	220/380	2,3,4	Yes
Jordan (Notes 1 & 2)					
Amman	a.c.50	1,3	220/380	2,4	Yes
Irbid	a.c.50	1,3	220/380	2,4	Yes
Nablus	a.c.50	1,3	220/380	2,4	Yes
Zerqa	a.c.50	1,3	220/380	2,4	Yes
Kuwait					
Kuwait	a.c.50	1,3	240/415	2,4	Yes
Lebanon					
Aley	a.c.50	1,3	110/190	2,4	No
Beirut	a.c.50	1,3	110/190	2,4	No
Bhamdoun	a.c.50	1,3	110/190	2,4	No
Brummana	a.c.50	1,3	110/190	2,4	No
Chtaure	a.c.50	1,3	110/190	2,4	No
Dhour el Choueir	a.c.50	1,3	110/190	2,4	No
Sidon	a.c.50	1,3	110/190	2,4	No
Sofar	a.c.50	1,3	110/190	2,4	No
Tripoli	a.c.50	1,3	220/380	2,4	No
Tyre	a.c.50	1,3	110/190	2,4	No
Zahleh	a.c.50	1,3	220/380	2,4	Yes

Country and City	Type and Frequency of Current	Number of Phases	Nominal Voltage	Number of Wires	Frequency Stable Enough for Electric Clocks
Libya (Notes 3 & 4)					
Al Aziziyah	a.c.50	1,3	127/220	2,4	No
Barce	a.c.50	1,3	230/400	2,4	No
Ben Gashir	a.c.50	1,3	127/220	2,4	No
Benghazi	a.c.50	1,3	230/400	2,4	No
Derna	a.c.50	1,3	230/400	2,4	No
El Baida	a.c.50	1,3	230	2,4	No
Homs	a.c.50	1,3	127/220	2,4	No
Misurata	a.c.50	1,3	127/220	2,4	No
Sebha	a.c.50	1	230	1	No
Tagiura	a.c.50	1,3	127/220	2,4	No
Tobruk	a.c.50	1,3	230/400	2,4	No
Tripoli	a.c.50	1,3	127/220	2,4	No
Zavia	a.c.50	1,3	127/220	2,4	No
Oman					
Muscat	a.c.50	1,3	220/440	2,3	No
Pakistan (Note 1)					
Abbotabad	a.c.50	1,3	230/400	2,3,4	Yes
Bahawalpur	a.c.50	1,3	230/400	2,3,4	Yes
Hyderabad	a.c.50	1,3	230/380	2,3,4	Yes
Islamabad	a.c.50	1,3	230/400	2,3,4	Yes
Karachi	a.c.50	1,3	230/380	2,3,4	Yes
Lahore	a.c.50	1,3	230/400	2,3,4	Yes
Lyallpur	a.c.50	1,3	230/400	2,3,4	Yes
Montgomery	a.c.50	1,3	230/400	2,3,4	Yes
Multan	a.c.50	1,3	230/400	2,3,4	Yes
Murree	a.c.50	1,3	230/400	2,3,4	Yes
Peshawar	a.c.50	1,3	230/400	2,3,4	Yes
Quetta	a.c.50	1,3	230/400	2,3,4	Yes
Rawalpindi	a.c.50	1,3	230/400	2,3,4	Yes
Saudi Arabia (Notes 5 & 6)					
Al Khobar	a.c.60	1,3	127/220	2,4	Yes
Buraydah	a.c.50	1,3	220/380	2,4	No
Dammam	a.c.60	1,3	127/220	2,4	Yes
Hofuf	a.c.50	1,3	230/400	2,4	Yes
Jiddah	a.c.60	1,3	127/220	2,3,4	Yes
Mecca	a.c.50	1,3	230/400	2,4	Yes
Medina	a.c.60	1,3	127/220	2,4	Yes
Riyadh	a.c.60	1,3	127/220	2,4	Yes
Taif	a.c.50	1,3	230/400	2,4	Yes

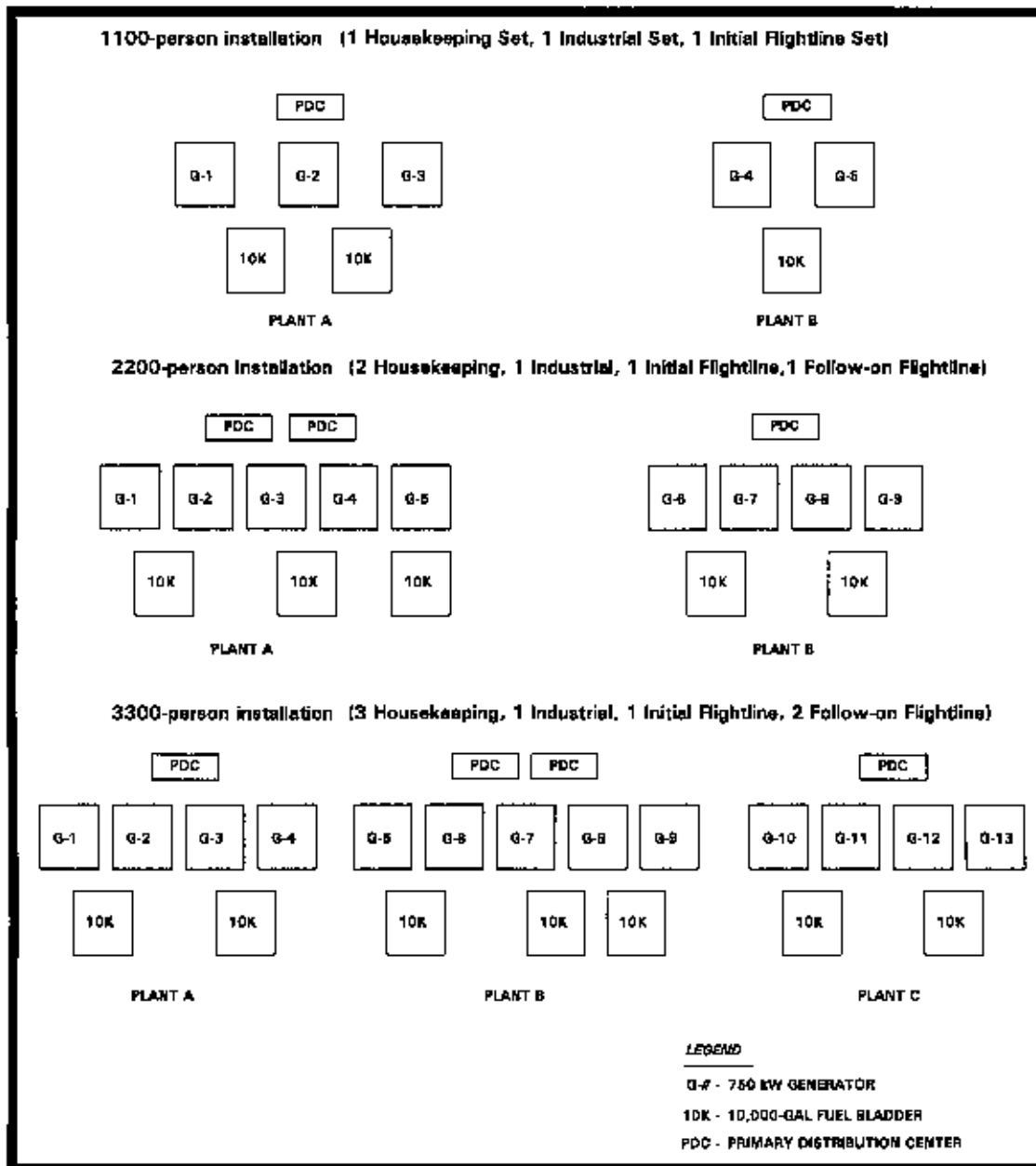
Country and City	Type and Frequency of Current	Number of Phases	Nominal Voltage	Number of Wires	Frequency Stable Enough for Electric Clocks
Sudan (Note 1)					
Atbara	a.c.50	1,3	240/415	2,4	Yes
Ed Daner	a.c.50	1,3	240/415	2,4	Yes
Ed Dueim	a.c.50	1,3	240/415	2,4	Yes
El Obeid	a.c.50	1,3	240/415	2,4	Yes
Hassa Heissa	a.c.50	1,3	240/415	2,4	Yes
Juba	a.c.50	1,3	240/415	2,4	Yes
Kassala	a.c.50	1,3	240/415	2,4	Yes
Khartoum	a.c.50	1,3	240/415	2,4	Yes
Khartoum N	a.c.50	1,3	240/415	2,4	Yes
Kosti	a.c.50	1,3	240/415	2,4	Yes
Malakal	a.c.50	1,3	240/415	2,4	Yes
Omdurman	a.c.50	1,3	240/415	2,4	Yes
Port Sudan	a.c.50	1,3	240/415	2,4	Yes
Sennar	a.c.50	1,3	240/415	2,4	Yes
Shendi	a.c.50	1,3	240/415	2,4	Yes
Wadi Halfa	a.c.50	1,3	240/415	2,4	Yes
Wau	a.c.50	1	240	2	Yes
Syria					
Aleppo	a.c.50	1,3	115/200	2,3,4	No
Damascus	a.c.50	1,3	115/200	2,3,4	No
Dayr-Al-Zawr	a.c.50	1,3	220/380	2,3,4	No
Hama	a.c.50	1,3	115/200	2,3,4	No
Homs	a.c.50	1,3	115/200	2,3,4	No
Latakia	a.c.50	1,3	115/200	2,3,4	No
Turkey (Note 2)					
Adana	a.c.50	1,3	220/380	2,3,4	Yes
Adapazari	a.c.50	1,3	220/380	2,3,4	Yes
Afyon	a.c.50	1,3	220/380	2,3,4	Yes
Ankara	a.c.50	1,3	220/380	2,3,4	Yes
Balikesir	a.c.50	1,3	220/380	2,3,4	Yes
Bursa	a.c.50	1,3	220/380	2,3,4	Yes
Eskisehir	a.c.50	1,3	220/380	2,3,4	Yes
Gaziantep	a.c.50	1,3	220/380	2,3,4	Yes
Istanbul	a.c.50	1,3	220/380	2,3,4	Yes
Izmir	a.c.50	1,3	220/380	2,3,4	Yes
Izmit	a.c.50	1,3	220/380	2,3,4	Yes
Kayseri	a.c.50	1,3	220/380	2,3,4	Yes
Knaya	a.c.50	1,3	220/380	2,3,4	Yes
Malatya	a.c.50	1,3	220/380	2,3,4	Yes
Manisa	a.c.50	1,3	220/380	2,3,4	Yes

Country and City	Type and Frequency of Current	Number of Phases	Nominal Voltage	Number of Wires	Frequency Stable Enough for Electric Clocks
Turkey (Continued)					
Mersin	a.c.50	1,3	220/380	2,3,4	Yes
Samsun	a.c.50	1,3	220/380	2,3,4	Yes
Sivas	a.c.50	1,3	220/380	2,3,4	Yes
Trabzon	a.c.50	1,3	220/380	2,3,4	Yes
Zonguldak	a.c.50	1,3	220/380	2,3,4	Yes
Yeman (Arab Rep.)					
Hoeida	a.c.50	1,3	220	2,3	No
Sana	a.c.50	1,3	220	2,3	No
Taiz	a.c.50	1,3	220	2,3	No
NOTES: 1. A grounding conductor is required in the electrical cord attached to appliances. 2. The neutral wire of the secondary distribution system is grounded. 3. Electric current is now continuous in most of the cities and large towns. 4. The neutral wire of the secondary distribution system is grounded except in the case of Sebba. 5. Grounding conductors are not required and many houses are not wired for a separate ground. 6. Power supply being standardized at 60 Hz, 127/200V.					

POWER PLANT LAYOUTS

A5.1. Sample power plant layouts for 1,100-, 2,200-, and 3,300-person installations are shown in figure A5.1. The diagrams depict a dispersed operation. Rearrangements of the plants can be made to suit site specific limitations on base facility placement.

Figure A5.1. Power Plant Layouts.



MISSION ESSENTIAL POWER (MEP) CABLE

60-AMP CABLES	50-FEET	100 FEET
Aircraft Hangar	4	4
General Purpose Shelter	2	2
Expandable Shelter Container	1	1
Personnel Shelter	1	1
Tents/(Billets) w/Air Conditioner	1 for 2	1 for 2
Reverse Osmosis Water Purification Unit	2	2
Secondary Distribution Center	2	4
Remote Area Light Set	1	2
5-kVA Avionics ESC additional (Note 1)	1	1
15-kVA Avionics ESC additional (Note 2)	2	2
1,200-cu ft Walk-In Refrigerators	1	1
Laundry Set	1 for 2	1 for 2
9-1 Kitchen	14	6
Shower/Shave Unit	1	1
<p>NOTE 1--All avionic intermediate maintenance ESCs require air conditioners be connected directly to the secondary distribution center (SDC) to minimize voltage fluctuation to the ESC (one cable for power requirements in the ESC and one cable for the air conditioner).</p> <p>NOTE 2--Avionic shelters utilizing a 15-kVA, 400-cycle converter require two 60-amp service cables in parallel for the power requirements in the ESC and a separate cable for the air conditioner.</p>		

ELECTRICAL PLANNING

A7.1. Introduction. Bare base electrical systems are pre-engineered; however, they must be tailored to each beddown location. You must determine the electrical load on each secondary distribution center (SDC) and then determine the electrical load on each primary feeder. To do this, you must know the power that will be required for each facility. The information contained in this section will assist you in this task. This section is divided into three areas. The first area lists the power requirements for bare base facilities. The next area provides an example of a secondary feeder for a typical wing operations facility group at a 3,300-person base. The last area contains typical electrical distribution schematics of both primary and secondary systems.

A7.2. Facility Power Requirements. Table A7.1 details the power requirements for all bare base facilities. The first column indicates the facility group being supported. The second column lists the title of the facility. The third column lists the facility type. The next column lists the maximum power (in kVA) the facility will draw. This does not include air conditioning. The fifth column lists the amount of mission essential power (MEP) to be supplied to each facility. The next column lists the power required for air conditioning. The last two columns are the most important. These columns list the diversified load each facility will draw. Use these numbers for calculating secondary feeder schedules. When facilities require more than one circuit, this is shown as well. Bear in mind that the electrical loads shown for the various facilities are estimated in many cases. Oftentimes users bring additional or differing equipment which could alter these figures. If time permits, a check should be on what equipment is actually being supported particularly in those areas relating to flightline maintenance operations. Do not be surprised to see containerized facilities arrive; some organizations such as the hospital have these types of buildings for specialized functions. During your planning efforts it would be wise to save a couple of circuits from the SDCs for these specialized types of facilities, at least in the hospital and aircraft maintenance facility group areas.

Table A7.1. Facility Power Requirements.							
FACILITY GROUP	FUNCTION	SHELTER TYPE	KILOVOLT-AMPERE			DIVERSIFIED LOAD	
			NORMAL POWER	MEP	AC	CIRCUIT #1	CIRCUIT #2
A Avionics	Avionics 15 kVA	ESC	15.0	10.5	10	20.5	10
	Gen Avionics Sup	GP	15.0		20	20.5	
	Latrine	TT	6.0			4.2	
B Billeting	Billet	TT	4.5		10	13.2	
	Latrine	TT	6.0			4.2	
	Shower	TT	6.0			4.2	
C Chaplain	Chapel	TT	7.8		10	15.5	
DA MWRS	Dining Hall	TT					
E Engineer	Engr Command	TT	5.2	3	10	13.6	10
	Engr Mgt	TT	4.9		10	13.4	
	Mat Cont	TT	7.0		10	14.9	
	Engr Ops	TT	4.6		10	13.2	
	Utilities	TT	5.8		10	14.1	
	Structures	TT	11.6		10	18.1	
	HVAC	TT	7.8		10	15.5	
	Fuels	TT	7.2		10	15.0	
	Electrical	TT	7.3		10	15.1	
	Entomology	TT	5.8		10	14.1	
	Power Pro	GP	9.7		20	16.8	
	Equipment	GP	6.9		20	14.8	
	Power Pro	ESC	5.8		10	14.1	
	Water Plant	TT	5.0		10	13.5	
	Latrine	TT	6.0			4.2	
	Engr Support	GP	6.9		20	14.8	
F Maint	Pneudraulics	ESC	28.1	20	10	19.7	10
	NDI	ESC	7.7		10	15.4	
	Propulsion	FSTFS	36.0	21		15.2	10
	Propulsion	GP	15.0	10	20	20.5	10
	Electrical	ESC	15.6	11	10	20.9	
	Bearing Clean	ESC	5.8		10	14.1	
	AGE	GP	8.2	6	20	15.7	10
	Cmd/Admin	TT	6.2	4	10	14.3	
	Parachute	ESC	6.6	5	10	14.6	
	Hangar	ACH	36.0	25		15.2	10
	Wheel/Tire	ESC	6.0		10	14.2	
	Latrine	TT	6.0			4.2	
	Gen Maint Sup	GP	10.0		20	17.0	10
	Gen Maint Sup	ESC	8.0		10	15.6	

Table A7.1. Facility Power Requirements (Continued).							
FACILITY GROUP	FUNCTION	SHELTER TYPE	KILOVOLT-AMPERE			DIVERSIFIED LOAD	
			NORMAL POWER	MEP	AC	CIRCUIT #1	CIRCUIT #2
G Sqd Ops	Sqd Ops	TT	5.9	4	10	14.1	10
	Life Support	ESC	5.7	4	10	14.0	
	Latrine	TT	6.0		20	4.2	
	Sqd Ops Support	GP	6.5			14.6	
H Com Sup	Reproduction	TT	5.6		10	13.9	10
	Post Office	TT	3.9		10	12.7	
	BITS	TT	5.2		10	13.6	
	Legal/Cont.	TT	4.9		10	13.4	
	Personnel	TT	4.6		10	13.2	
	Administration	TT	5.0		10	13.5	
	Latrine	TT	6.0			4.2	
	Exchange	TT	6.0		10	14.2	
	Exchange	ESC	8.0		10	15.6	
	Gen Support	GP	7.0		20	14.9	
	Comm Fac	ESC	9.0	6	10	16.3	
	MWRS	TT	4.6		10	13.2	
	Armory	ESC	4.5		10	13.2	
	Cmd/SRC	ESC	4.5	4	10	13.2	
I Emerg Sys	Tech Services	TT	5.0	4	10	13.5	
	Fire Ops	TT	4.5	3	10	13.2	
	Security Police	TT	4.5	3	10	13.2	
	Dis Prep	TT	4.5		10	13.2	
	EOD	TT	6.2	4	10	14.3	
	Base Ops	TT	4.5		10	13.2	
J Aerial Pt	Mortuary	TT	6.3	4	10	14.4	10
	Aerial Port	TT	4.5	3	10	13.2	
	Port Support	GP	6.5		20	14.6	
L Laundry	Laundry	TT	10		10	17.0	
M Munition	Admin/Cmd	TT	6.5	5	10	14.6	10
	Tool Crib	TT	5.0	4	10	13.5	
	Mun Maint	GP	8.2	6	20	15.7	
P POL	Admin	TT	5.4		10	13.8	
	Lab	ESC	4.5		10	13.2	
R Alert	Alert Fac	TT	5.4	4	10	13.8	

Table A7.1. Facility Power Requirements (Continued).							
FACILITY GROUP	FUNCTION	SHELTER TYPE	KILOVOLT-AMPERE			DIVERSIFIED LOAD	
			NORMAL POWER	MEP	AC	CIRCUIT #1	CIRCUIT #2
S Supply	Admin/Cmd	TT	5.1		10	13.6	
	Demand Proc	ESC	5.1		10	13.6	
	Latrine	TT	6.0			4.2	
	Storage	FSTFS	10.0			7.0	
T Trans	Vehicle Ops	TT	4.5		10	13.2	
	TMO	TT	4.5		10	13.2	
	Latrine	TT	6.0			4.2	
	Veh Maint	FSTFS	18.5			13.0	
	Pack/Crate	FSTFS	12.0			8.4	
W Wing	Admin	TT	5.7		10	14.0	
	Briefing	TT	7.0	5	10	14.9	
	Plans	TT	4.5		10	13.2	
	Operations	TT	4.6		10	13.2	
	Targets	TT	4.5	3	10	13.2	
	Intel	TT	5.6	4	10	13.9	
	Intel	ESC	5.6	4	10	13.9	
	Maint Cmd	TT	4.5		10	13.2	
	Job Cont	TT	4.8	4	10	13.4	
	Mat Cont	TT	6.3	4	10	14.4	
	QC	TT	6.3	4	10	14.4	
	Maint An	TT	4.5		10	13.2	
	Maint Rec	TT	4.5		10	13.2	
	Maint Plans	TT	6.3		10	14.4	
	Latrine	TT	6.0			4.2	
	Admin/Cmd	ESC	5.7	4	10	14.0	
	Finance	TT	4.5		10	13.2	

A7.3. Example Secondary Distribution Schedule. Table A7.2 represents an example computation for secondary distribution schedules. A wing operations facility group for a 3,300-person base is used. With this information facilities can be assigned to SDCs. In this example, facilities of the same type were grouped together as much as possible. When necessary, facilities were arranged to minimize the need for MEP generators. In other words, put facilities that need MEP together to provide a full load for a MEP generator. By totalling the power requirements for each facility, the total power requirement for the facility group is 379.2 kVA. A total of three 150 kVA SDCs will be required for the facility group. To facilitate laying out the facilities in a dispersed layout, they have generally been equally distributed between each of the three SDCs (ten facilities on the first SDC, nine each on the second and third). A MEP generator was assigned to the SDC having a significant MEP requirement. A second MEP generator would eventually be assigned to the second SDC having MEP requirements once additional MEP loads from adjacent facility groups were identified or a smaller generator became available. Example feeder schedules are shown in table A7.3.

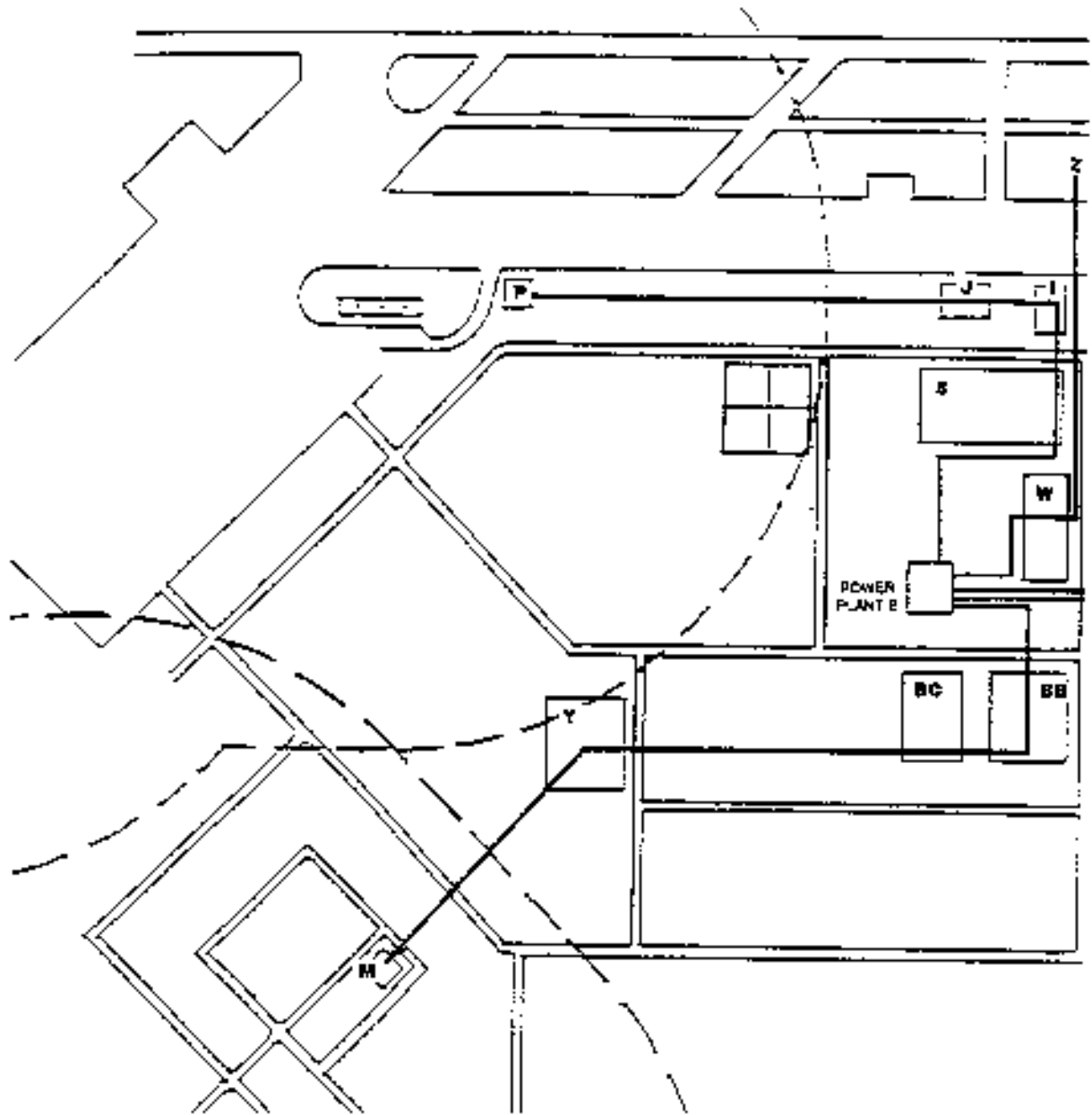
Table A7.2. Example Secondary Distribution Schedule.					
FUNCTION	FACILITY TYPE	NO.	kVA CIRCUIT		MEP kVA
			#1	#2	
Administration	TT	2	14.0		5
Briefing	TT	6	14.9		
Plans	TT	1	13.2		
Operations	TT	3	13.2		
Targets	TT	2	13.2		3
Intel	TT	1	13.9		4
Intel	ESC	1	13.9		4
Maint Supervision	TT	2	13.2		
Job Control	TT	1	13.4		4
Matériel Cont	TT	1	14.4		4
Quality Cont	TT	1	14.4		4
Maint Analysis	TT	1	13.2		
Maint Records	TT	1	13.2		
Maint Plans	TT	1	14.4		
Latrine	TT	1	4.2		
Finance	TT	1	13.2		
Command Post	ESC	1	14.0		4
Admin/Command	ESC	1	14.0		

Table A7.3. Example Feeder Schedules.					
FACILITY GROUP	CIRCUIT	NO.	FACILITY	kVA	MEP
(SDC-W1) Wing Operations	1	W1	Briefing Facility	14.9	5
	2	W2	Briefing Facility	14.9	5
	3	W3	Briefing Facility	14.9	5
	4	W4	Briefing Facility	14.9	5
	5	W5	Briefing Facility	14.9	5
	6	W6	Briefing Facility	14.9	5
	7	W7	Targets	13.2	3
	8	W8	Targets	13.2	3
	9	W9	Intel	13.9	4
	10	W10	Intel	13.9	4
			TOTAL kVA	143.6	
			TOTAL MEP kVA		44
			MEP GENERATOR 60 kW		
(SDC-W2) Wing Operations	1	W11	Job Control	13.4	4
	2	W12	Materiel Command	14.4	4
	3	W13	Quality Control	14.4	4
	4	W14	Command Post	14.0	4
	5	W15	Maint Super	13.2	
	6	W16	Maint Super	13.2	
	7	W17	Maint Analysis	13.2	
	8	W18	Maint Records	13.2	
	9	W19	Maint Plans	14.4	
			TOTAL kVA	123.4	
			TOTAL MEP kVA 16		
			MEP GENERATOR		
(SDC-W3) Wing Operations	1	W20	Administration	14.0	
	2	W21	Ops Plans	13.2	
	3	W22	Current Ops	13.2	
	4	W23	Current Ops	13.2	
	5	W24	Current Ops	13.2	
	6	W25	Admin/Command	14.0	
	7	W26	Finance	13.2	
	8	W27	Latrine	4.2	
	9	W28	Administration	14.0	
			TOTAL kVA	112.2	

A7.3. Typical Electrical Distribution Schematics. Figures A7.1, A7.2, and A7.3, respectively, are typical schematics of primary electrical distribution system layouts for 1,100-, 2,200-, and 3,300-person bare bases. You can use these examples as a guide to tailor the electrical distribution system to fit your base. Figures A7.4 through A7.12 depict secondary distribution systems from the PDCs at each power plant supporting an 1,100-person installation. Keep in mind several variations of the secondary system can be made depending on base layouts and loads. Much of the load on the electrical system results from use of air conditioners for most base facilities. For planning purposes the following comments relating to secondary distribution system design and air conditioning in particular should be a major consideration.

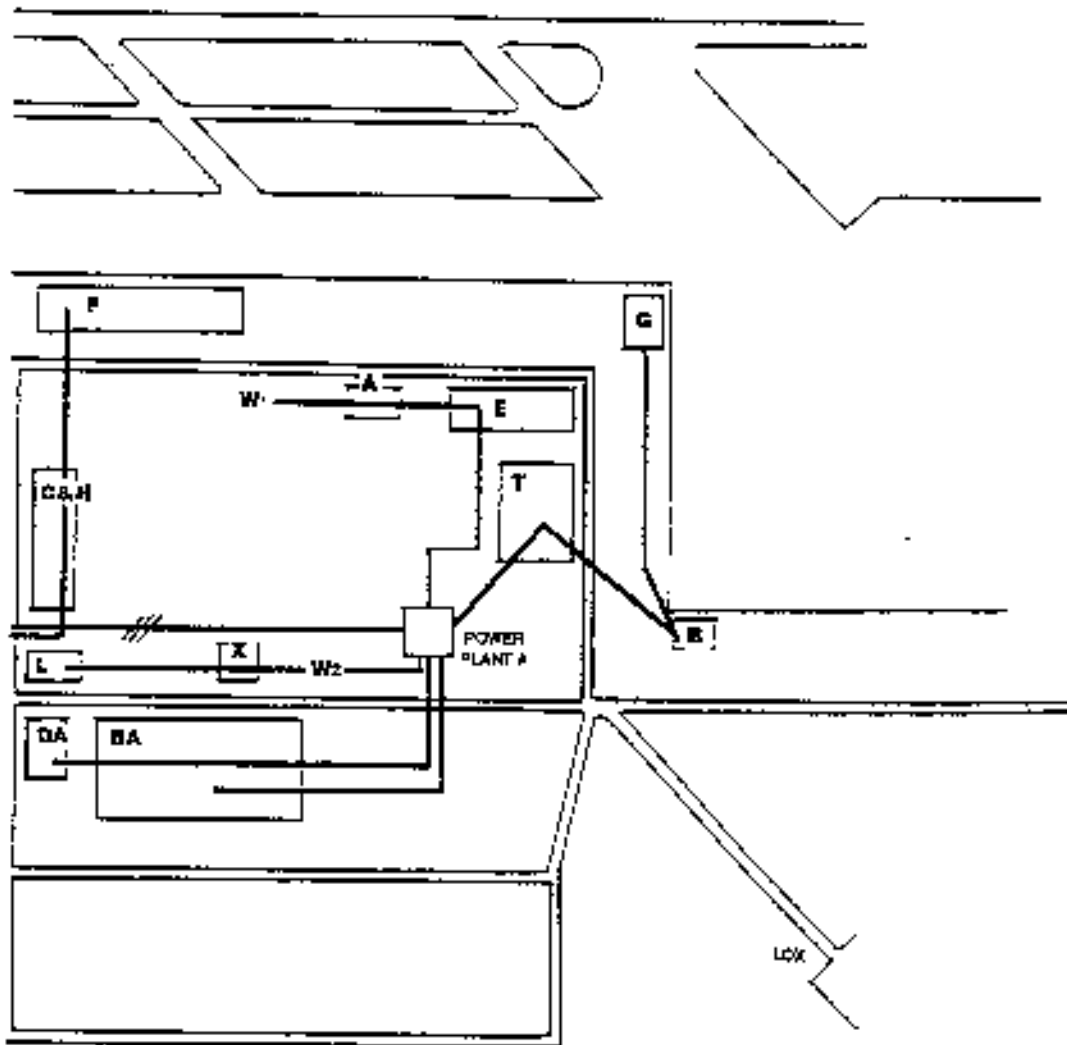
- A bare base 5-ton air conditioner draws nearly 26 amps at full load. An 150- kVA SDC can deliver an average of 26 amps (45 amps phase-to-phase) to its 16 output circuits. If 16 shelters with air conditioning are connected to a single SDC, there is no margin to run other equipment if all the air conditioning is operating. Therefore, use the following guidelines.
 - 12 shelters maximum per SDC. This allows 35 amps per shelter or 9 amps per phase per shelter exclusive of air conditioning.
 - 10 shelters per SDC allows 41 amps per shelter or 15 amps per phase per shelter exclusive of air conditioning.
 - 7 shelters per SDC allows 60 amps per shelter or 34 amps per phase per shelter exclusive of air conditioning.
- Put no more than five SDCs on a single 200 amp circuit from a PDC.
- Put no more than 30 SDCs on a single PDC.
- The load on each SDC circuit should not exceed 21.6 kVA.
- The load on each SDC should not exceed 150 kVA.

Figure A7.1. Electrical Primary Distribution System (1,100-person).



**ELECTRICAL PRIMARY
DISTRIBUTION SYSTEM**
POPULATION 1,100

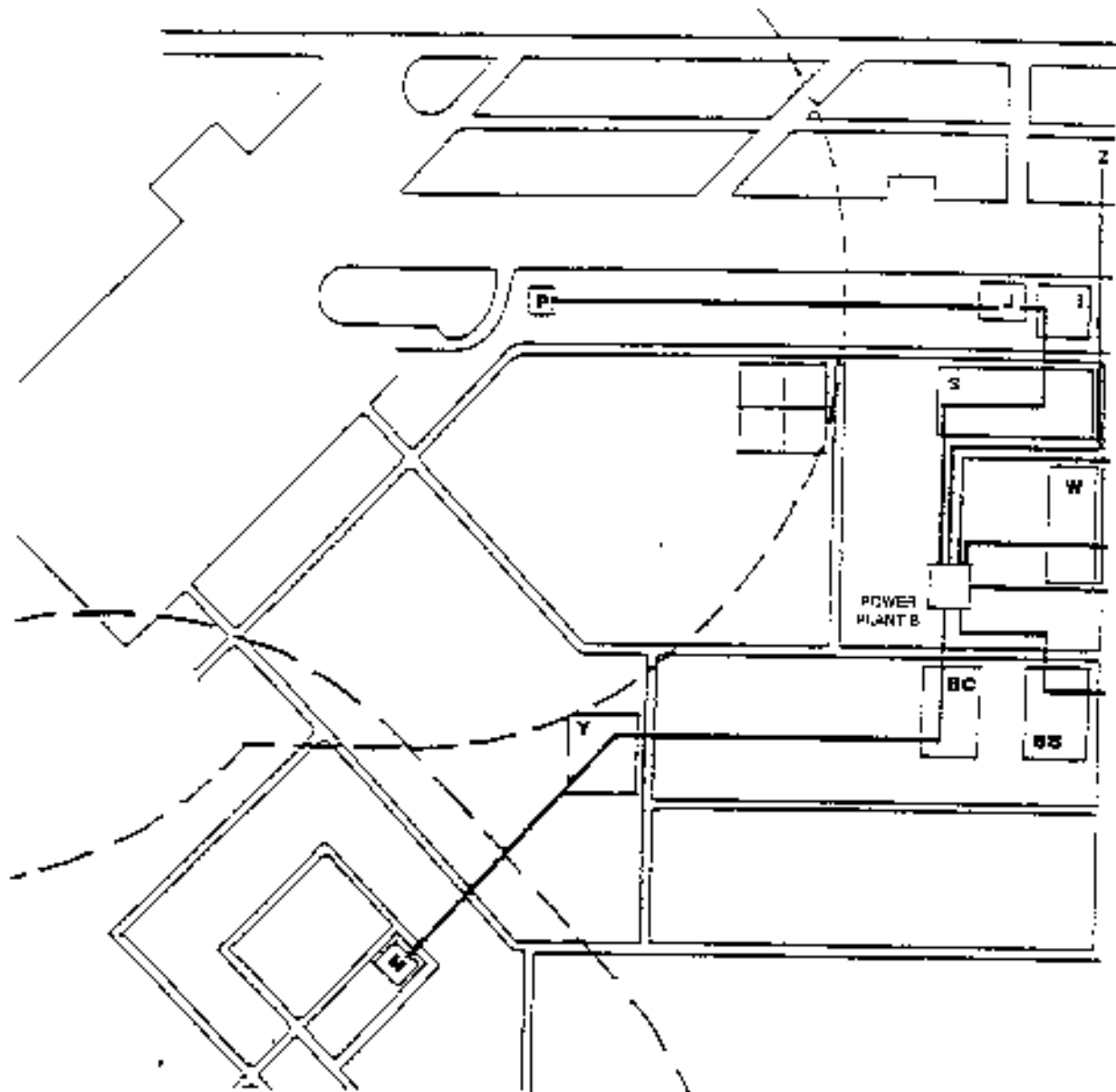
Figure A7.1. Electrical Primary Distribution System (1,100-person) (continued).



1,100-PERSON BASE BASE FACILITY LIST

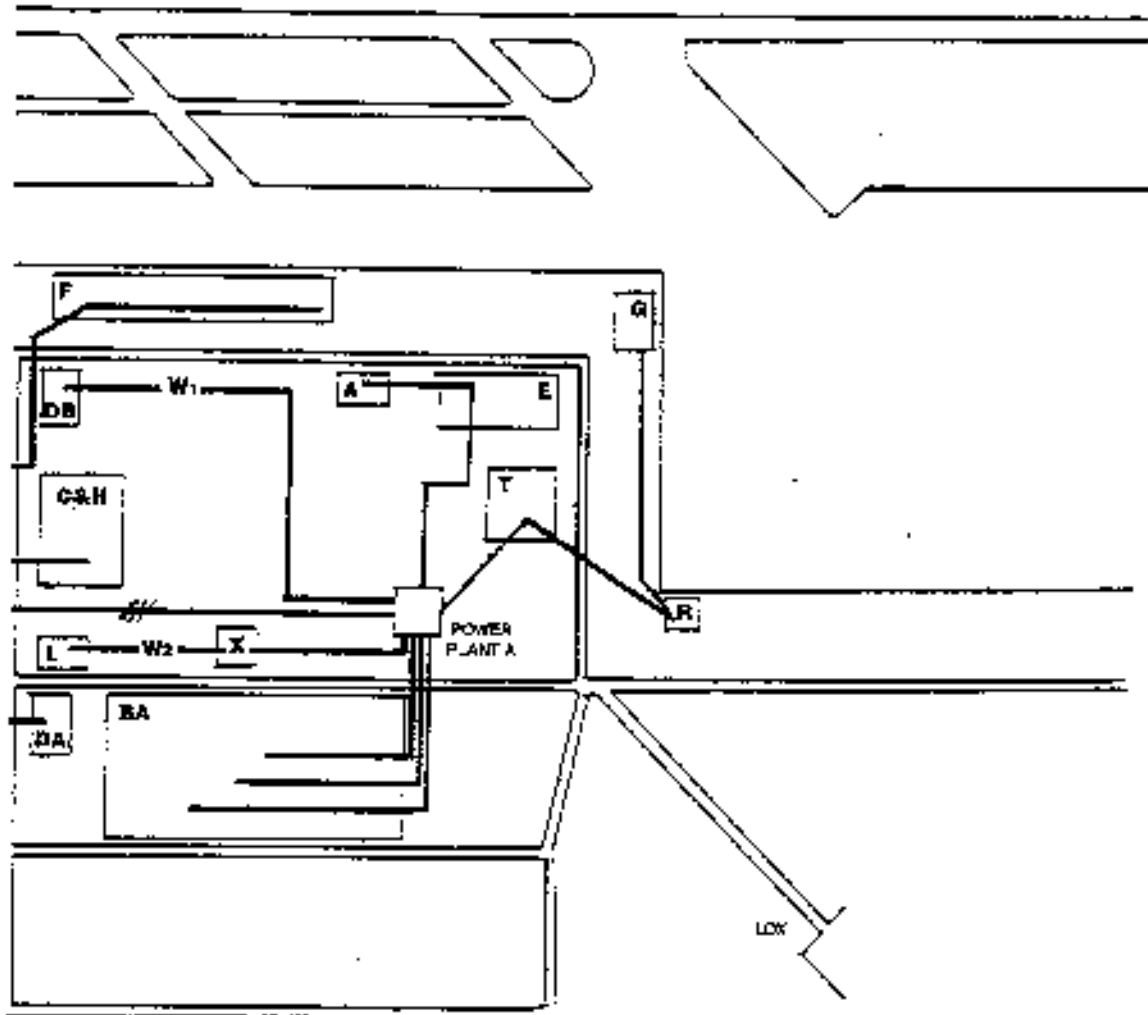
AREA	FACILITY GROUP	STRUCTURE TYPE			
		TH	SC	#	FRACH PSTP.
A	AVIONICS			3	
BA	BELTING UNITS	77			
BB	BILLETING FEMALE	18			
BC	BILLETING OFFICER	10			
C	CHAPEL				
CA	SERVICES	100-1			
E	ENGINEER	14	1	9	
F	MAINTENANCE	4	10	5	2
G	SQUADRON OPERATIONS	1	1		
H	SUPPORT GROUP	4	6	2	
I	EMERGENCY SERVICES	10			
J	AERIAL PORT	3		1	
L	LAUNDRY	2			
M	MUNITIONS			3	
P	POL	1	1		
R	ALERT	3			
S	SUPPLY	2	2		7
T	TRANSPORTATION	2			8
W	WING OPERATIONS	18	3		
X	HOSPITAL				
Y	COMMUNICATIONS				
Z	AIRFIELD FACILITIES				
W1	WATER PLANT #1				
W2	WATER PLANT #2				

Figure A7.2. Electrical Primary Distribution System (2,200-person).



**ELECTRICAL PRIMARY
DISTRIBUTION SYSTEM**
POPULATION 2,200

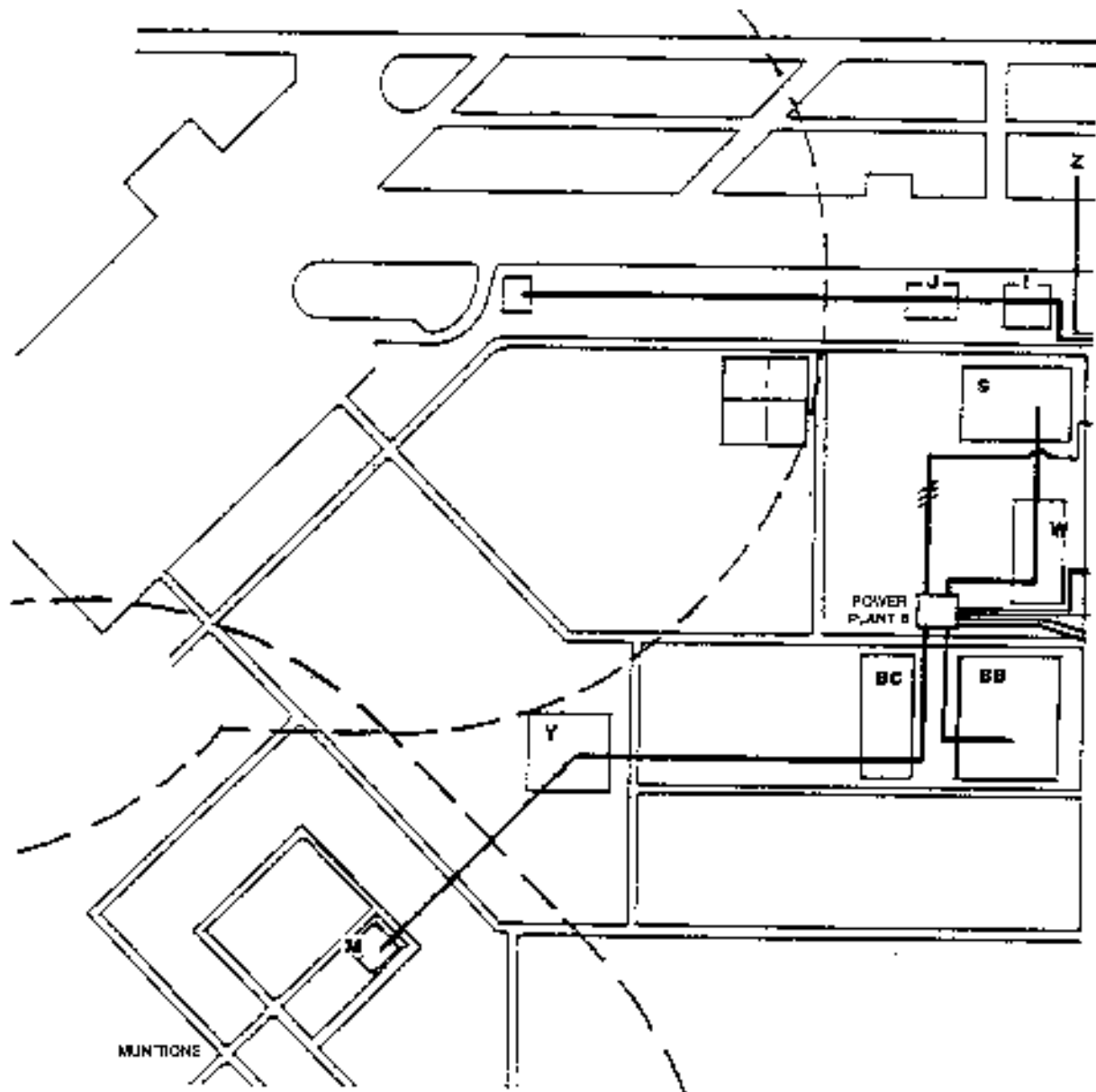
Figure A7.2. Electrical Primary Distribution System (2,200-person) (continued).



2,200-PERSON BARE BASE FACILITY LIST

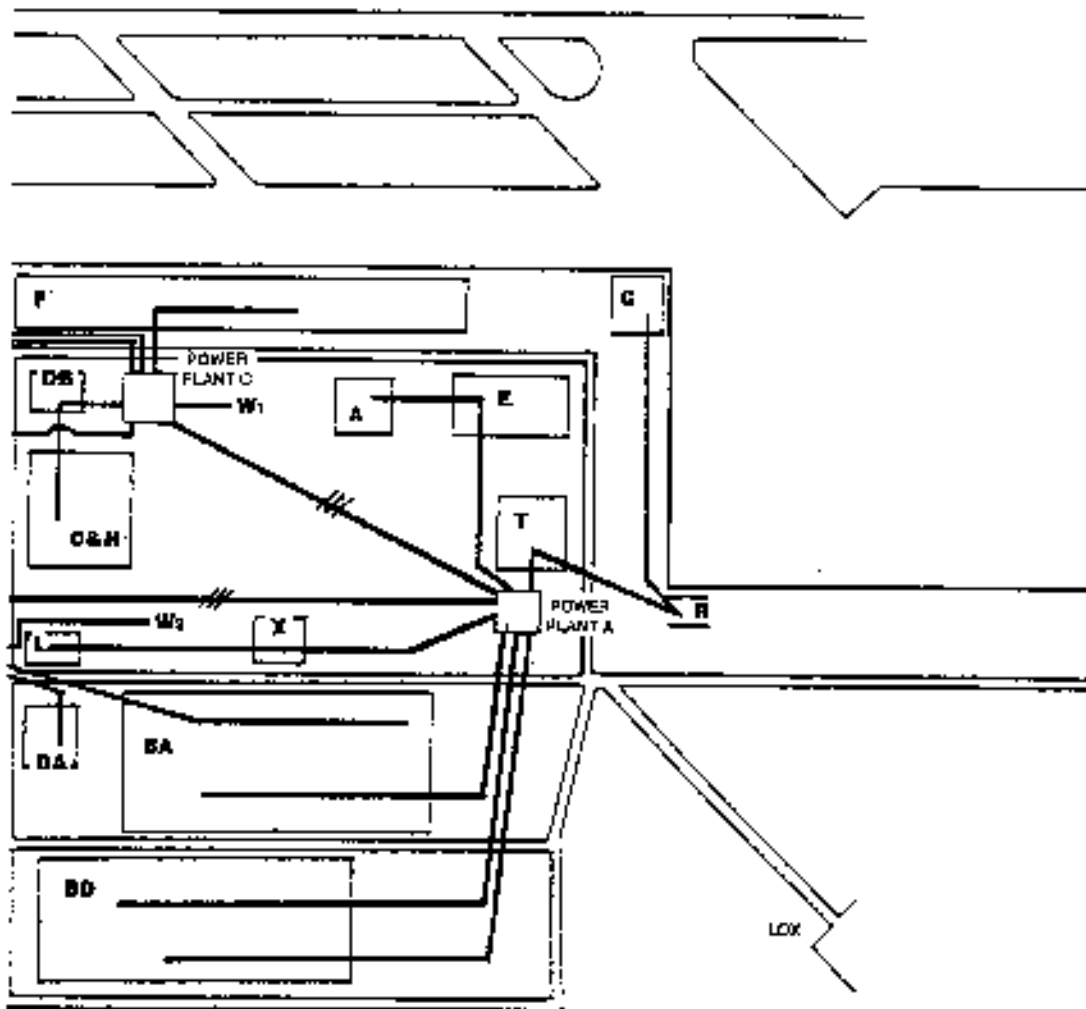
AREA	FACILITY GROUP	STRUCTURE TYPE			
		TOWERS OR SPACESHIPS			
A	ARMORIES	1	2	4	
BA	BILLETING MALE	100			
BB	BILLETING FEMALE	20			
BC	BILLETING OFFICER	10			
C	CHAPEL	1			
DA	SERVICES	10-12			
DB	SERVICES FUTURE	10-11			
E	ENGINEER	10	2	3	
F	MAINTENANCE	6	11	8	2
G	SQUADRON OPERATIONS	3	2	2	
H	SUPPORT GROUP	14	6	2	
I	EMERGENCY SERVICES	11			
J	AERIAL PORT	4		1	
L	LAUNDRY	4			
M	MUNITIONS	2		4	
P	POL	1			
R	ALERT	3			
S	SUPPLY	2	2		7
T	TRANSPORTATION	2			3
W	WING OPERATIONS	8	3		
X	HOSPITAL				
Y	COMMUNICATIONS				
Z	LAIRFIELD FACILITIES				
W1	WATER PLANT #1				
W2	WATER PLANT #2				

Figure A7.3. Electrical Primary Distribution System (3,300-person).



**ELECTRICAL PRIMARY
DISTRIBUTION SYSTEM**
POPULATION 3,300

Figure A7.3. Electrical Primary Distribution System (3,300-person) (continued).



3,300-PERSON BASE FACILITY LIST

AREA	FACILITY GROUP	STRUCTURE TYPE	TRANSFORMER	POLE	POLE
A	AGENCY	1	2	4	
BA	BILLETING ENLISTED	33			
BB	BILLETING FEMALE	54			
BC	BILLETING OFFICER	28			
BD	BILLETING ENLISTED	102			
C	CHAPEL	1			
DA	SERVICES	218-1			
DB	SERVICES (POLINE)	118-1			
E	ENGINEER	19	2	3	
F	MAINTENANCE	4	12	2	4
G	SQUADRON OPERATIONS	4	2	2	
H	SUPPORT GROUP	18	3	2	
I	EMERGENCY SERVICES	15			
J	AERIAL PLAT	9		2	
L	LAUNDRY	8			
M	MUNITIONS	2		6	
P	POL	1	1		
R	ALERT	9			
S	SUPPLY	3	2		7
T	TRANSPORTATION	3			1
W	WING OPERATIONS	25	3		
X	HOSPITAL				
Y	COMMUNICATIONS				
Z	AIRFIELD FACILITIES				
W1	WATER PLANT #1				
W2	WATER PLANT #2				

Figure A7.4. Circuit #1, Plant A.

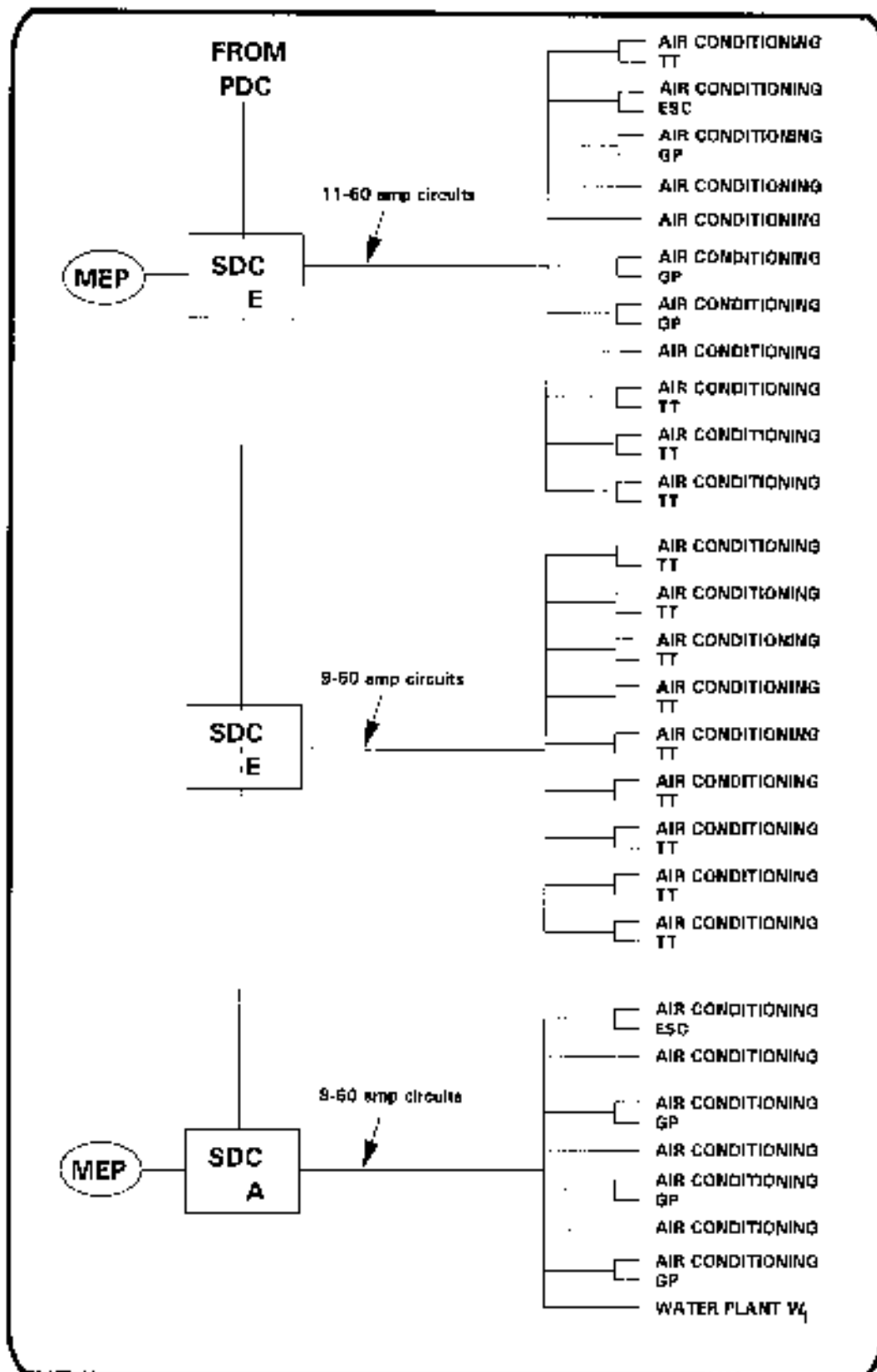


Figure A7.5. Circuit #2, Plant A.

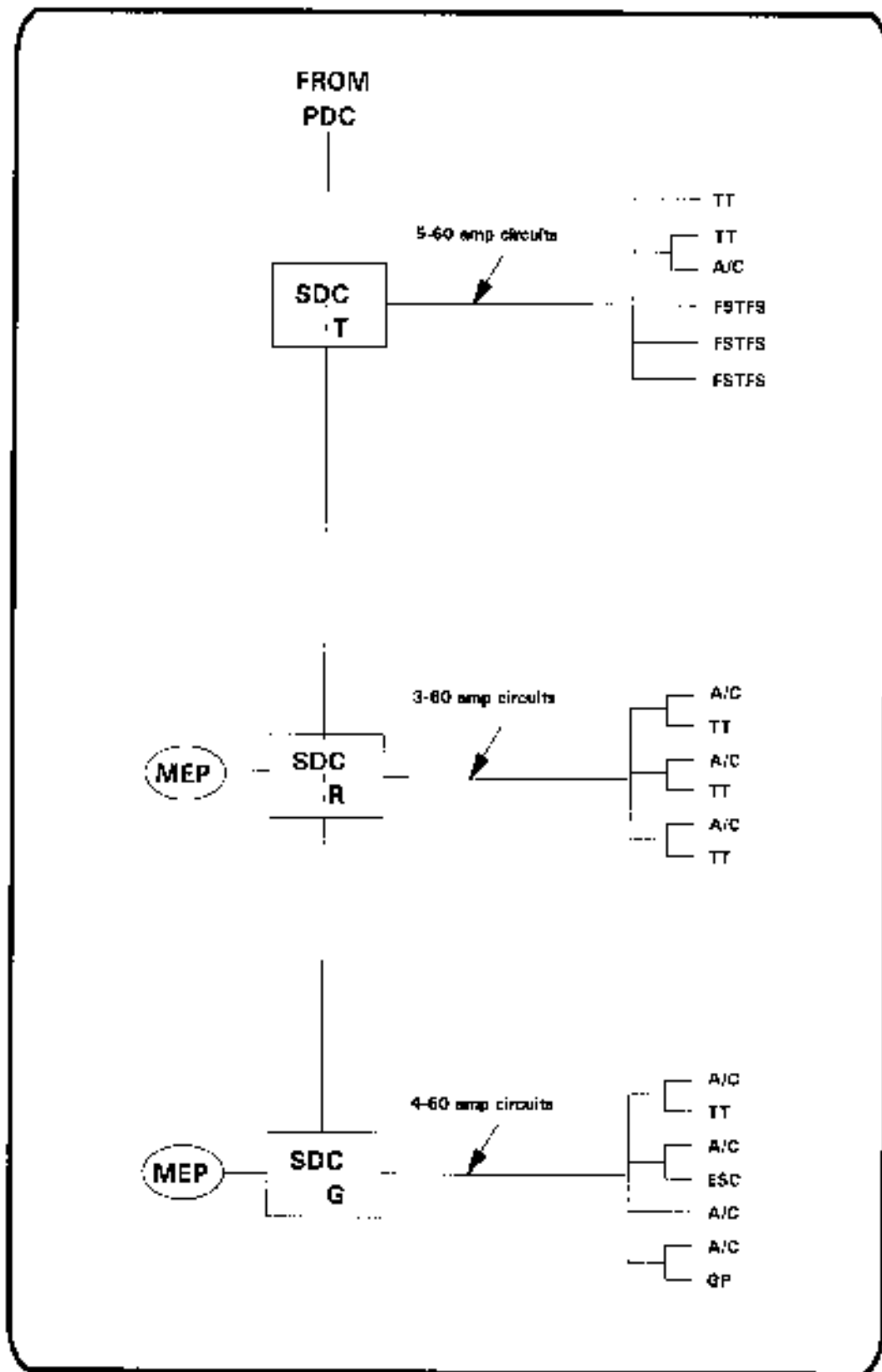


Figure A7.6. Circuit #3, Plant A.

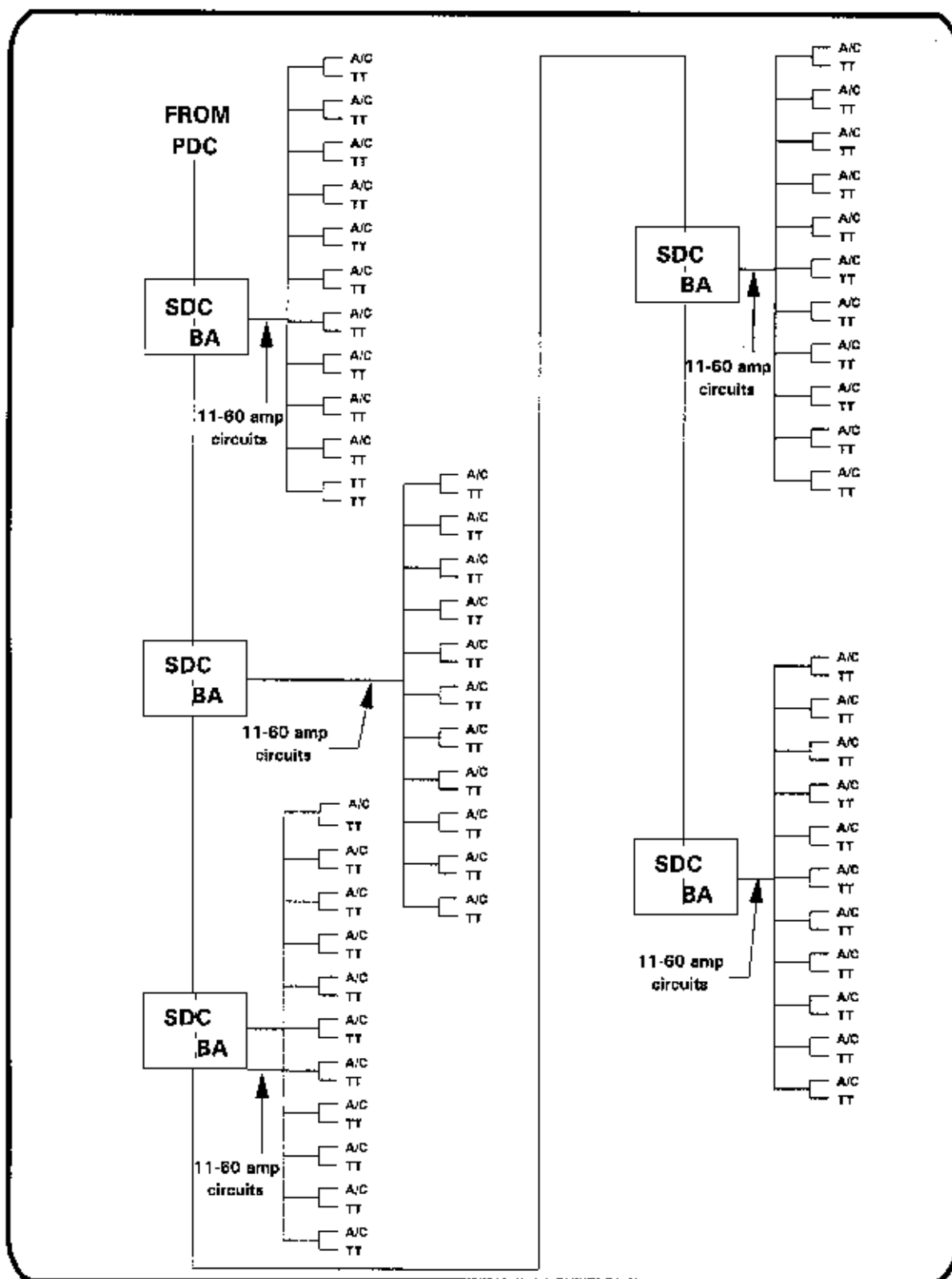


Figure A7.7. Circuit #4, Plant A.

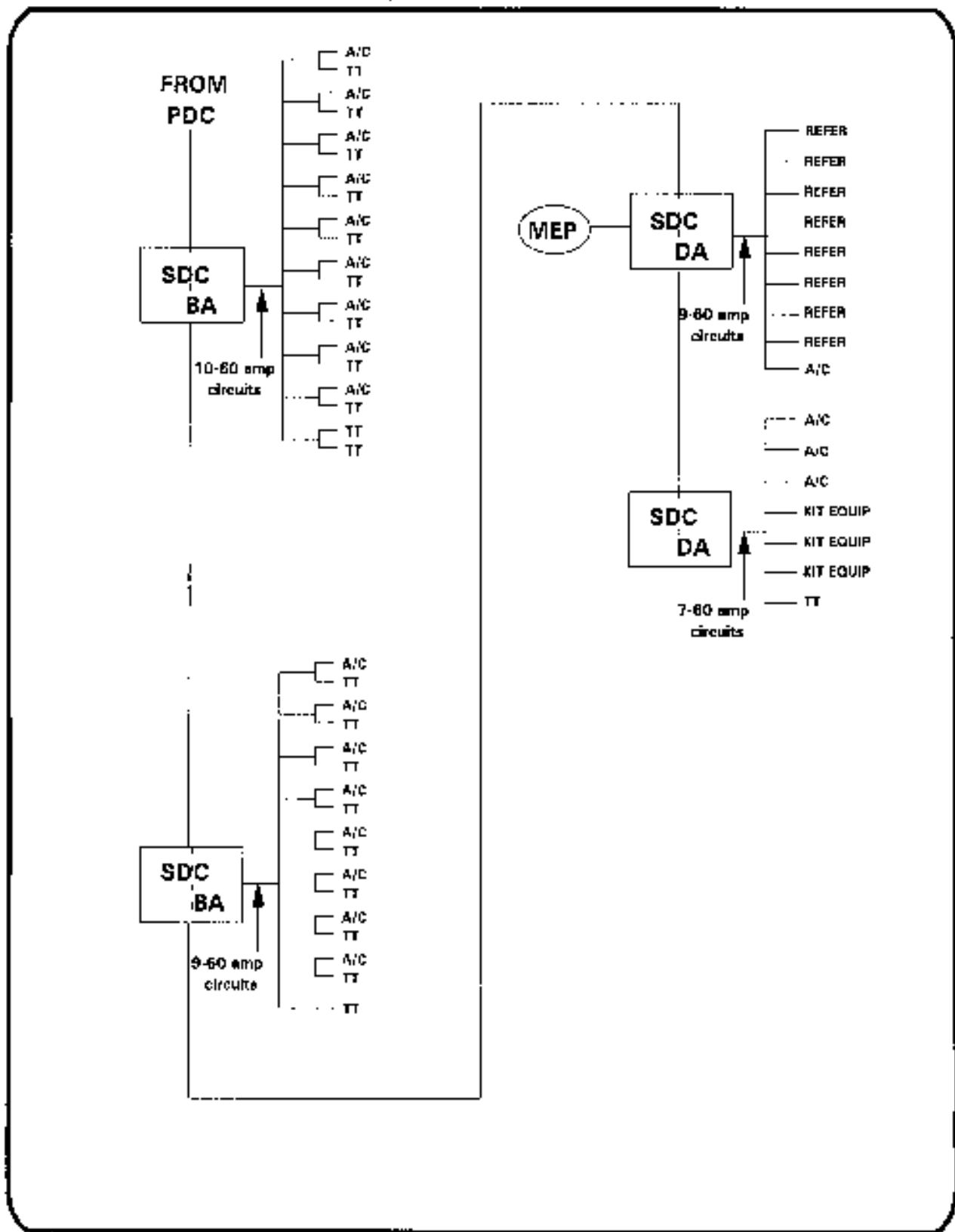


Figure A7.8. Circuit #5, Plant A.

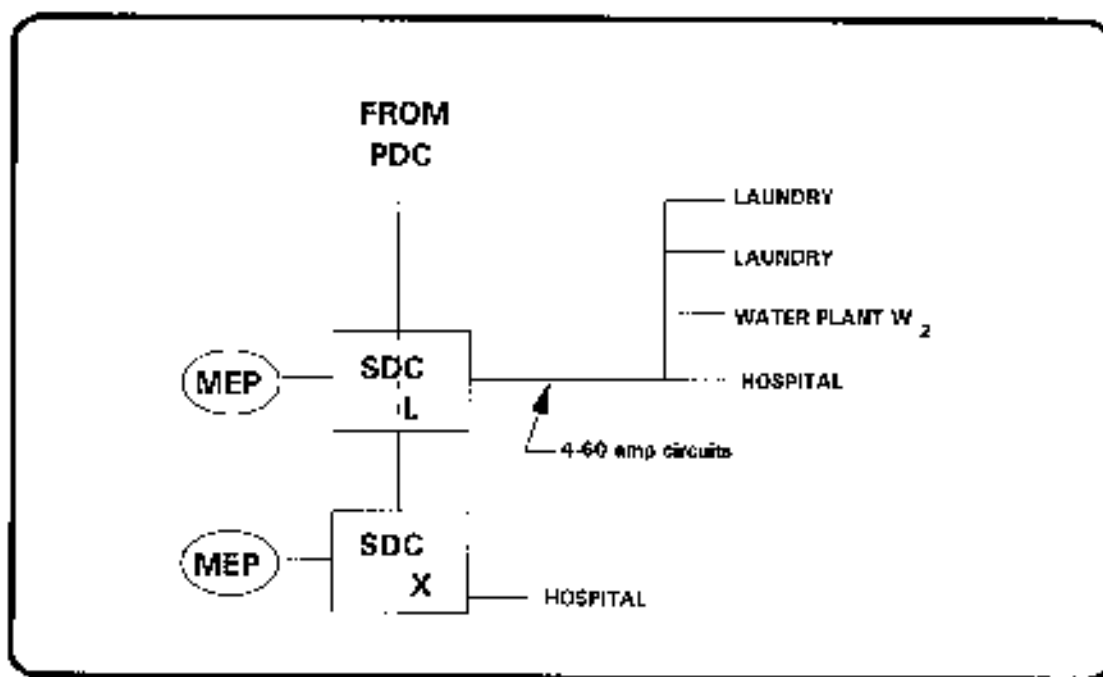


Figure A7.9. Circuit #1, Plant B.

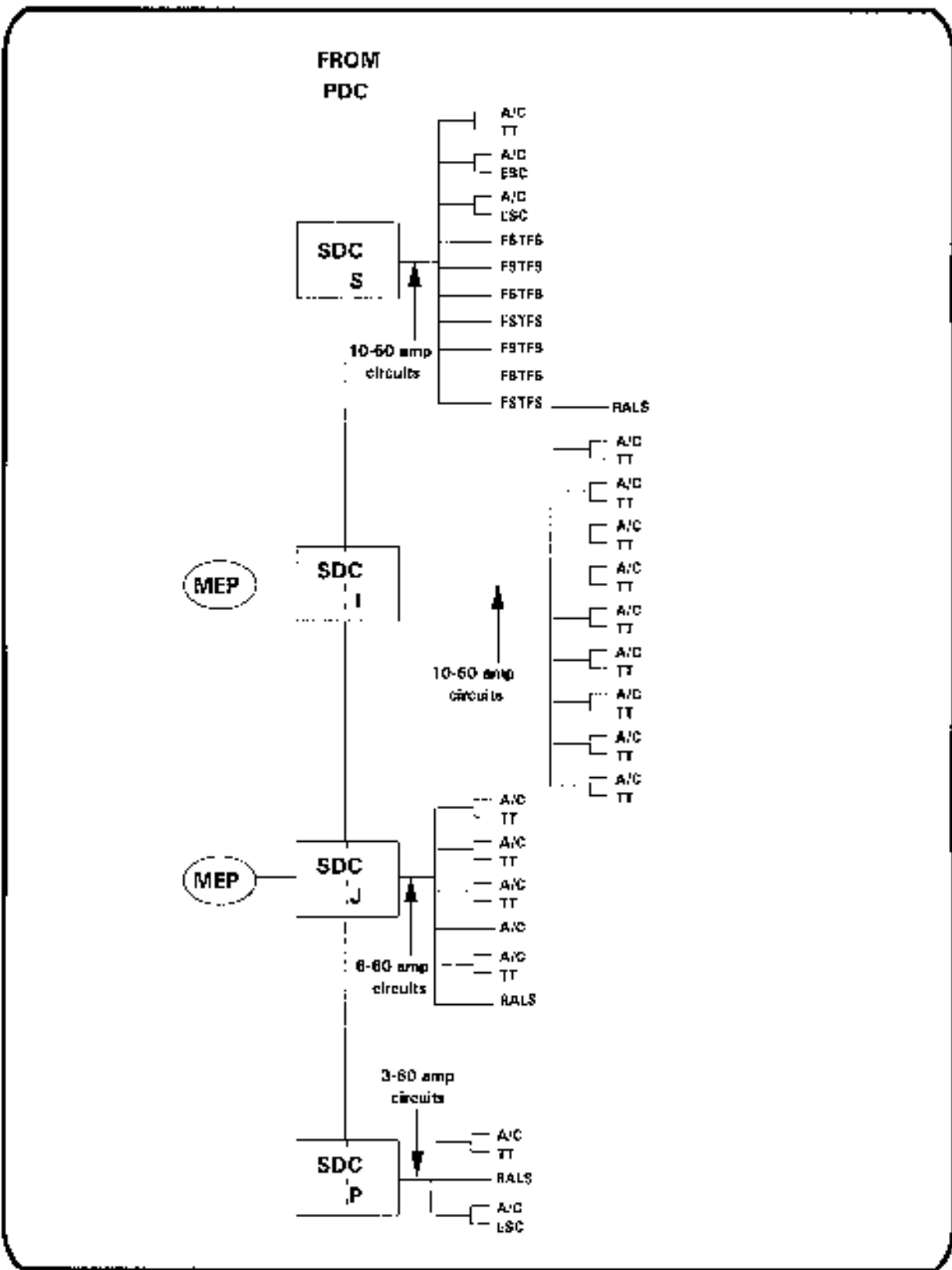
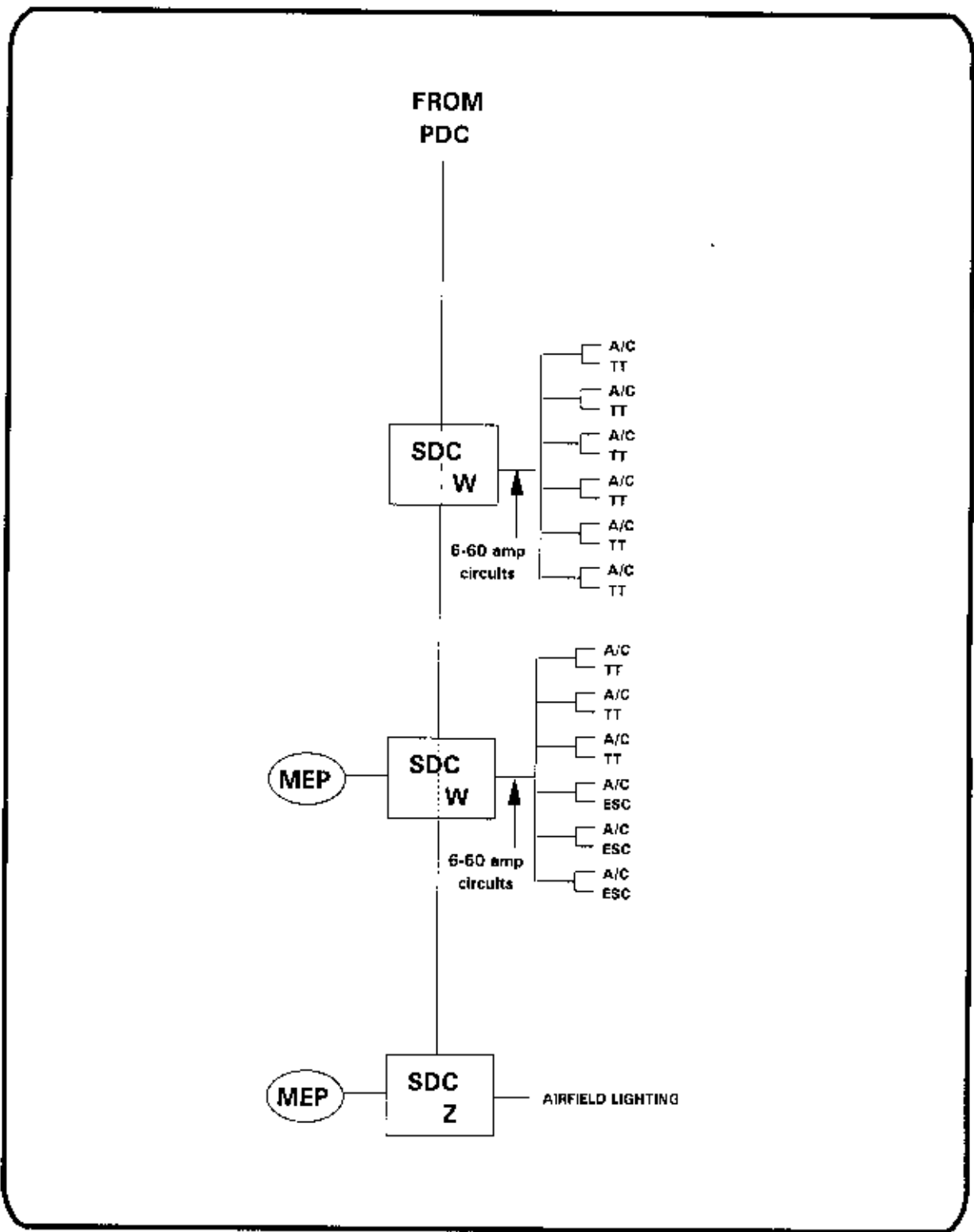


Figure A7.10. Circuit #2, Plant B.



The diagram illustrates the power distribution system for the Space Shuttle Main Engine (SE) and the External Tank (ET). It features three main power distribution units (SDC) connected to the Main Engine Power (MEP) and the External Tank Power (ETP). The SDC C/H units are connected to the MEP and the ETP, while the SDC F units are connected to the MEP. The SDC C/H units are connected to the ETP through a 10-60 amp circuit, and the SDC F units are connected to the ETP through a 15-60 amp circuit. The diagram also shows the connection of various loads (A/C, GP, ESC, TT) to the SDC units.

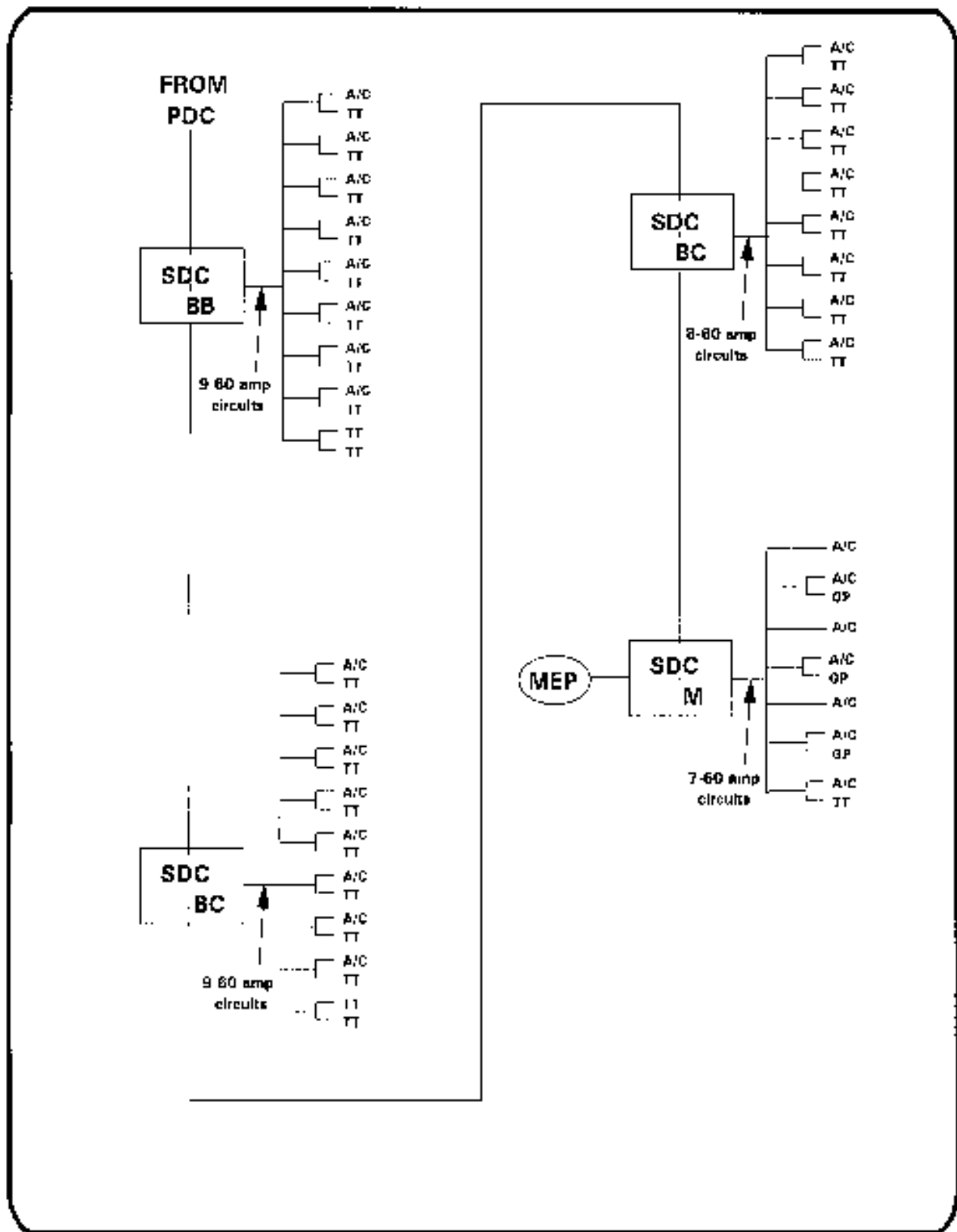
Left Side (SE Power Distribution):

- FROM PDC** input to **SDC C/H**.
- MEP** connected to **SDC C/H**.
- SDC C/H** outputs to **8-60 amp circuits** (A/C, TT, A/C, GP, A/C, ESC, A/C, ESC, A/C, ESC, A/C, ESC, A/C, ESC).
- SDC C/H** connected to **10-60 amp circuits** (A/C, GP, A/C, TT, A/C, TT, A/C, TT, A/C, TT, A/C, TT, A/C, TT).
- MEP** connected to **SDC F**.
- SDC F** outputs to **15-60 amp circuits** (A/C, A/C, ESC, A/C, A/C, ESC, A/C, ESC, A/C, FSTFS, ESC, A/C, A/C, ESC, TT, A/C, A/C, ESC).

Right Side (ET Power Distribution):

- MEP** connected to **SDC F**.
- SDC F** outputs to **15-60 amp circuits** (A/C, A/C, ACH, ESC, A/C, A/C, GP, A/C, A/C, GP, A/C, ESC, TT, A/C, A/C, GP).

Figure A7.12. Circuit #4, Plant B.



EXPEDIENT GROUNDING METHODS

A8.1. Grounding Objectives. The basic objectives of grounding are provided below. The key words in the objectives are "minimize" and "reduce." It is not possible to produce a system in which all risk and performance degradation are reduced to zero. Nevertheless, the objectives must be satisfied by any grounding technique known to be good engineering practice. Grounding objectives include:

A8.1.1. Minimize injuries to persons near electrical equipment by providing a low resistance path to the earth.

A8.1.2. Minimize damage and service interruptions due to all possible electrical faults, including lightning discharge.

A8.1.3. Reduce overvoltages and resultant insulation damage due to both normal operation (switching surges, static buildup) and abnormal operation (lightning, faults).

A8.1.4. Minimize noise in communication and control circuits by establishing a solid electrical reference.

A8.2. Grounding Levels. Levels of adequate grounding have been identified for bare base operations where personnel expertise, materials, time, and special equipment may be limited or not available. These levels are:

A8.2.1. Low voltage distribution system (generation at 600 volts or less) deployed only for a short period of time (up to four weeks) (LVST).

A8.2.2. Low voltage distribution system constructed for on-line use over longer periods of time (four weeks to two years) (LVLТ).

A8.2.3. High and medium voltage distribution systems (generation at greater than 600 volts) deployed for short-term operation (HVST).

A8.2.4. High and medium voltage distribution constructed for on-line, long-term operation (HVLТ).

A8.3. Grounding Techniques. The recommended grounding techniques to be used within each of these levels are discussed below. They apply to bases constructed in arid, sandy, or rocky areas where local water tables are very low, and to scenarios where ample water supplies are not readily available. In coastal regions and other locations where water tables are high and soils are relatively moist, traditional grounding methods normally provide excellent grounding, because of the high mineral and salt content of the soil. In coastal regions, corrosion of ground connections is a significant maintenance problem because corroded terminals and connections develop their own high resistance. This corrosion can be reduced by frequent, regular inspection, maintenance, and treatment of ground connections.

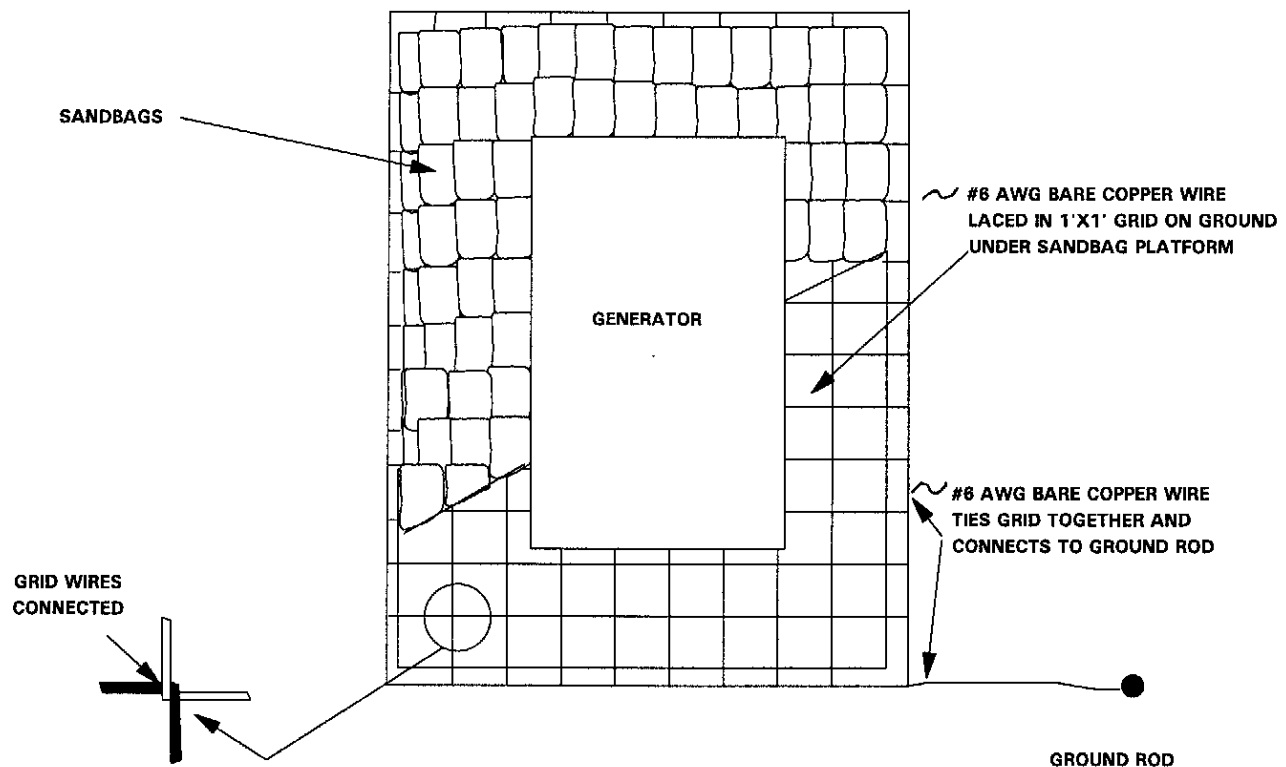
A8.3.1. LVST. The generators should be grounded with the standard driven ground rod. Where rods cannot be driven, they should be laid horizontally in a trench about 18 inches deep and covered with soil (not rocks). The distribution system's neutral wire must be connected through the generator to this ground. As long as this 3-phase system has a grounded neutral, further deliberate grounding at other locations is not required.

A8.3.2. LVLТ. This situation is probably most typical for a small bare base operation. The generators should be placed on an electrically gridded platform (either concrete or sandbags) that is tied to a standard ground rod driven a few feet away from the platform. A gridded platform is shown in figure A8.1. The platform must be large enough to permit the generator operator to stand on it while attending the generator. The generator and the distribution system neutral wire must also be connected to this ground grid and ground rod. Other distribution equipment, such as transformers, junction boxes, pedestals, and distribution panels, must also be locally grounded by standard ground rods. As water availability permits, the generator and other local ground rods should be treated with salt solutions poured directly on and around the rod to saturate the soil. This treatment should be repeated as necessary to keep the soil in contact with the rod moist. Normally, three pounds of salt per gallon of water gives a good saturated solution for this application. ROWPU brine water will also serve well for this purpose.

A8.3.3. HVST. Use of high or medium voltages in bare base operations may be necessary when the bare base receives power from large Air Force electrical distribution complexes, host nation power is used, or high voltage 750-kW generators are used to extend electric service within the base. Along with traditional grounding of generators, transformers, and junction boxes for short-term use, it is essential to have grounded neutral distribution, using the standard driven ground rod or trench buried rod in rocky areas. In addition to this initial grounding, a dedicated ground wire must be run from the generator grounding rod to all grounded locations on the base. This extra wire, or cable, may be laid in existing trenches or in separate trenching, or can be formed using the concentric neutral of 3-phase, 4-wire cables. It provides a common ground plane that is normally provided by the soils. This grounding wire is necessary to provide adequate safety for personnel operating electrical equipment.

A8.3.4. HVLTL. For system reliability and personnel safety, this longer-term scenario requires that the HVST grounding system described above be augmented with gridded ground planes for generators and surface-mounted transformers and direct contact of the grounding system with a known permanent water source, such as the local water table. It is anticipated that some form of water well will be present at the bare base where HVLTL applies. In this case, the grounding plane and dedicated ground wires should be connected to the metal well casing, or, a separate copper conductor can be lowered into the well to make contact with the water. If a water well is not available, other drilling operations will be necessary to establish positive electric contact with the local water table. Also, of prime importance in this grounding system is the continuous and frequent inspection of grounding connections and dedicated ground wires for electrical continuity and low resistance of connections. Cleaning of corrosion from, and protection of, these connections is critical in maintaining good system reliability and safety.

Figure A8.1. Expedient Generator Grounding Grid.



A8.3.5. The preceding outline of "adequate" grounding levels was developed based on assumptions of construction in very dry sandy, and rocky terrain. Personnel standing on such soils form a relatively high-resistance electrical path to ground, as

do driven ground rods. In low voltage systems, then even a direct short to ground through an airman will not be a significant health hazard, though an unpleasant electrical shock could be sensed. In high and medium voltage systems, however, this type of short passing through personnel could result in electrocution. Therefore, a dedicated ground wire should be used for high voltage systems. In effect, this extra wire serves the same purpose as the soil in normal moist environments. It ensures that faulting currents have a path back to the generator, thus tripping appropriate circuit protection devices. Concentric neutral cables used in distribution systems can be used to provide this dedicated ground wire.

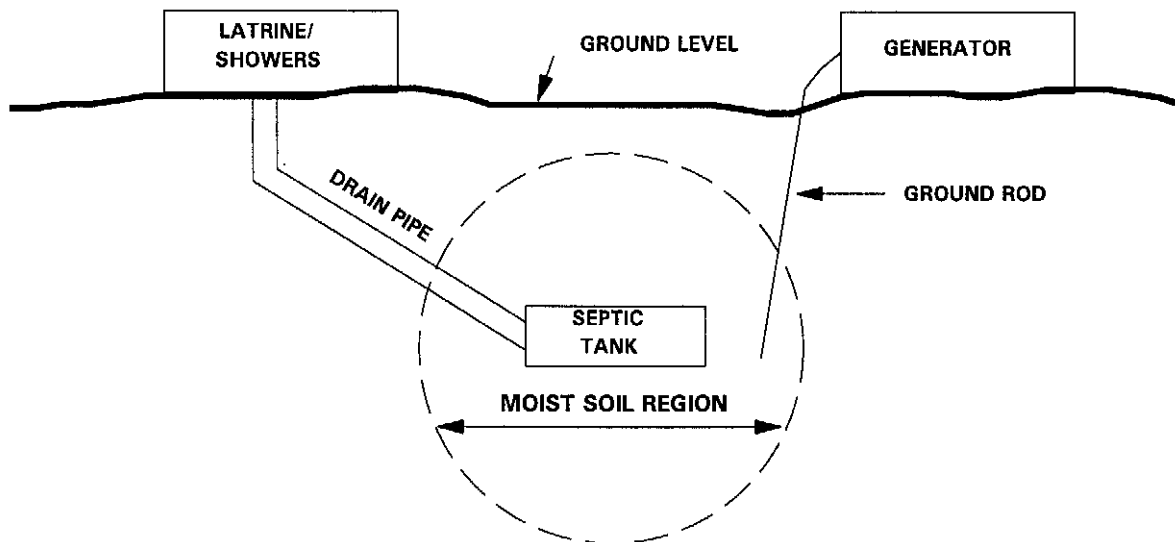
A8.4. Other Site Selection Factors. The following outlines other site selection factors that should be considered before emplacement of the generation and distribution system to improve the system's grounding effectiveness. As noted earlier, highly arid and sandy base sites with low water tables allow no ideal solutions for grounding electric distribution systems with traditionally available Air Force grounding equipment. However, other regions in SWA may provide at least reasonable opportunities for good electrical grounding when sites are selected carefully.

A8.4.1. Existing water sources such as oases, river beds, or underground streams often indicate that local water tables are high enough to be contacted with driven ground rods. Deep wells can be used as described earlier to easily tie the entire grounding system to earth potential using dedicated grounding cables and grids. These water sources can also be used to dampen the soil around local ground rods.

A8.4.2. If a bare base is developed in an area that is already built up, then electrical contact with existing water piping systems can provide excellent ground conditions. The rebar in reinforced concrete can serve the same function as horizontal ground rods do. Another good location for grounding would be an existing metal sewage system. Finally, existing metal fencing can be used to construct electrical grids for generators and SDCs.

A8.4.3. In locations where such structures or water sources are not available, distribution grounding can be improved by driving ground rods near or into operational waste water dumps or sinks. For instance, dining halls and latrines may use evaporation ponds or cesspools. Sewage liquids are normally very conductive. However, care should be exercised to ensure that this ground connection does not endanger personnel should a fault occur. Figure A8.2 shows grounding using wastewater drainage. The drain pipe must not be constructed with metal materials. Plastic or PVC is recommended if the sewage drain is used for ground. This will prevent the possible injection of current into the water source (latrine or dining hall).

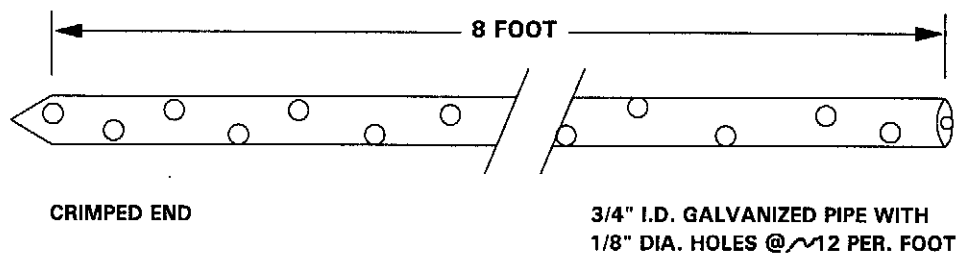
Figure A8.2. Grounding Using Sewage System.



A8.5. Field Expedient Techniques. Two expedient techniques for local grounding are particularly applicable to field situations.

A8.5.1. The first technique can be easily used in deep, loose, dry sand where a "quick fix" ground is needed. Figure A8.3 shows how an 8-foot section of galvanized steel or copper clad pipe can be modified to aid immediate introduction of salt solution to the rod and sand surface. After being driven into the ground, the perforated pipe is filled through a funnel with a solution of 15 pounds salt per 5 gallons water. The salt solution percolates into the sand and provides a conductive soil for current flow. The ground remains effective until the solution either evaporates or drains away from the rod, usually in several hours or a few days. This procedure tends to corrode the pipe very quickly; frequent replacement of pipe will be necessary. Also, the grounding clamp and wire connection must be kept clean and corrosion-free for good results.

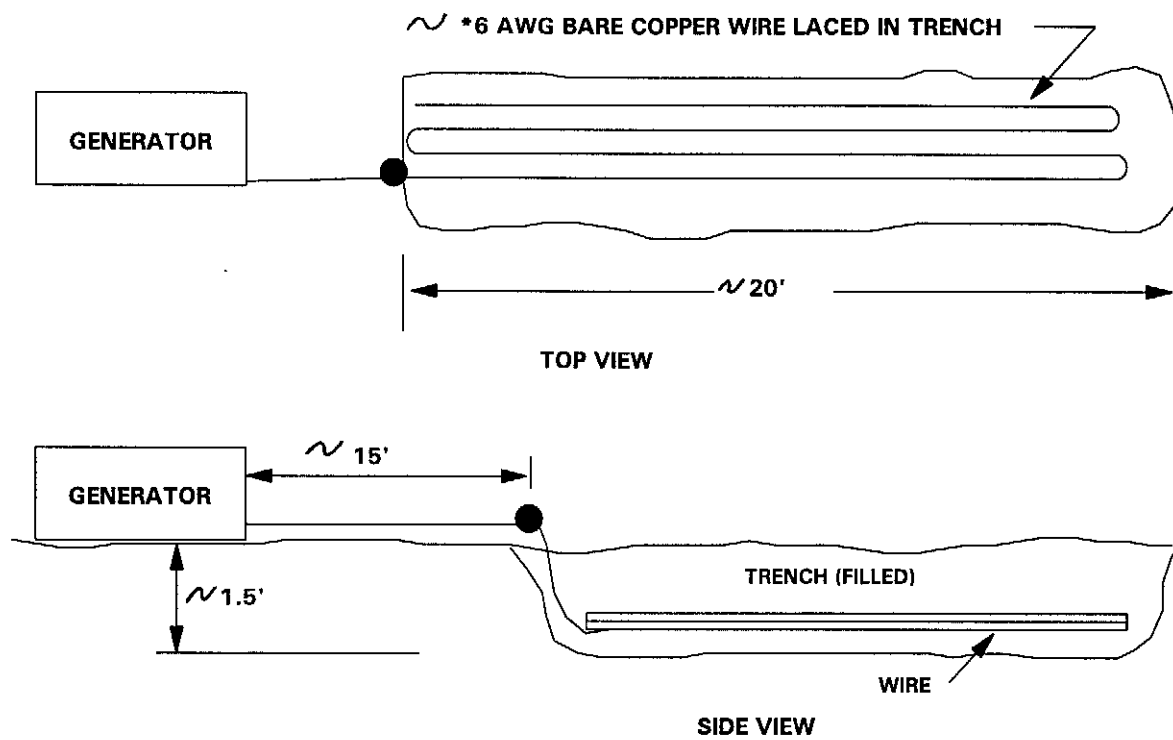
Figure A8.3. Expedient Grounding Pipe.



A8.5.2. The second technique, which is most useful in rocky terrain where rods are difficult to drive, has been loosely called "counterpoise." Bare copper wire is laid in a horizontal trench and is covered with soil and salt solution treatment, if available. More wire in the trench, usually 1-1/2 feet deep, provides a better ground. A "counterpoise" of this type is shown in figure A8.4. With this technique, too, the wire becomes unrecoverable after several salt solution treatments. Note, however, that some field users have employed this type of ground successfully without salt solution treatment. Another expedient grounding method that may be applicable is direct ground connection to field urinal tubes driven into the soil. This technique is recommended only for short-term use.

A8.6. Though this attachment has outlined levels of grounding that are acceptable in an expedient sense, it is nevertheless emphasized that grounding protection of less than 25 ohms resistance to earth is desirable and should be a goal of the electric distribution crew. To determine the grounding status of grounded locations, it is recommended that on-site capability be provided for ground resistance testing. Although grounding resistance of less than 25 ohms will not be possible in some dry sandy areas, the traditional techniques of deeper ground rods, rods in parallel, and rods treated with salt solution will significantly decrease the high local resistance, and will improve electrical system reliability and safety.

Figure A8.4. Expedient Grounding Trench.



WATER PLANT LAYOUTS

Sample water plant layouts for 1,100-, 2,200-, and 3,300-person installations are shown in figures A9.1 through A9.3. The diagrams depict dispersed operations and address minimum ROWPU requirements for the populations supported. A handful of additional ROWPUs are included in the Harvest Falcon set to allow proper maintenance procedures to be followed and provide a margin of operating safety. These units are not shown and may be placed at water plant(s) as deemed best by the user. Typical details of various water plant connections are shown in figures A9.4 through A9.9.

Figure A9.1. Typical Water Treatment Plants -- 1100-person.

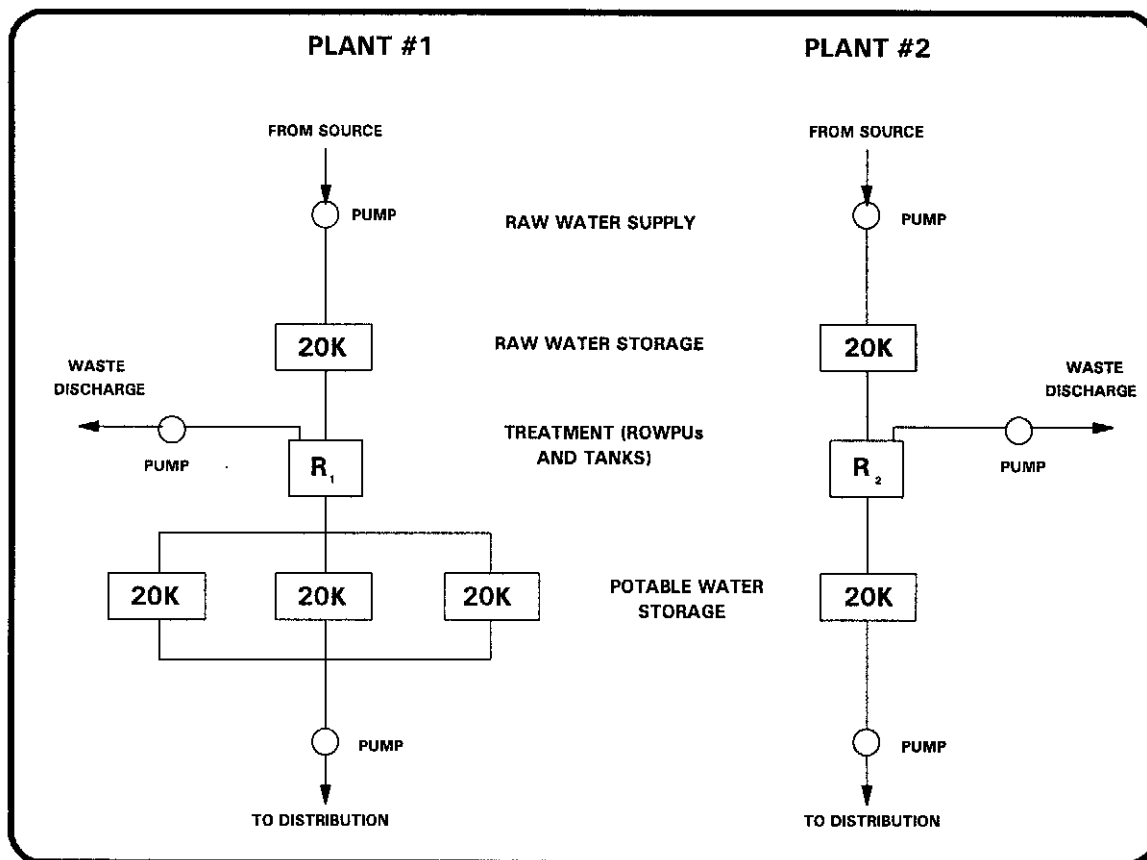


Figure A9.2. Typical Water Treatment Plants -- 2200-person.

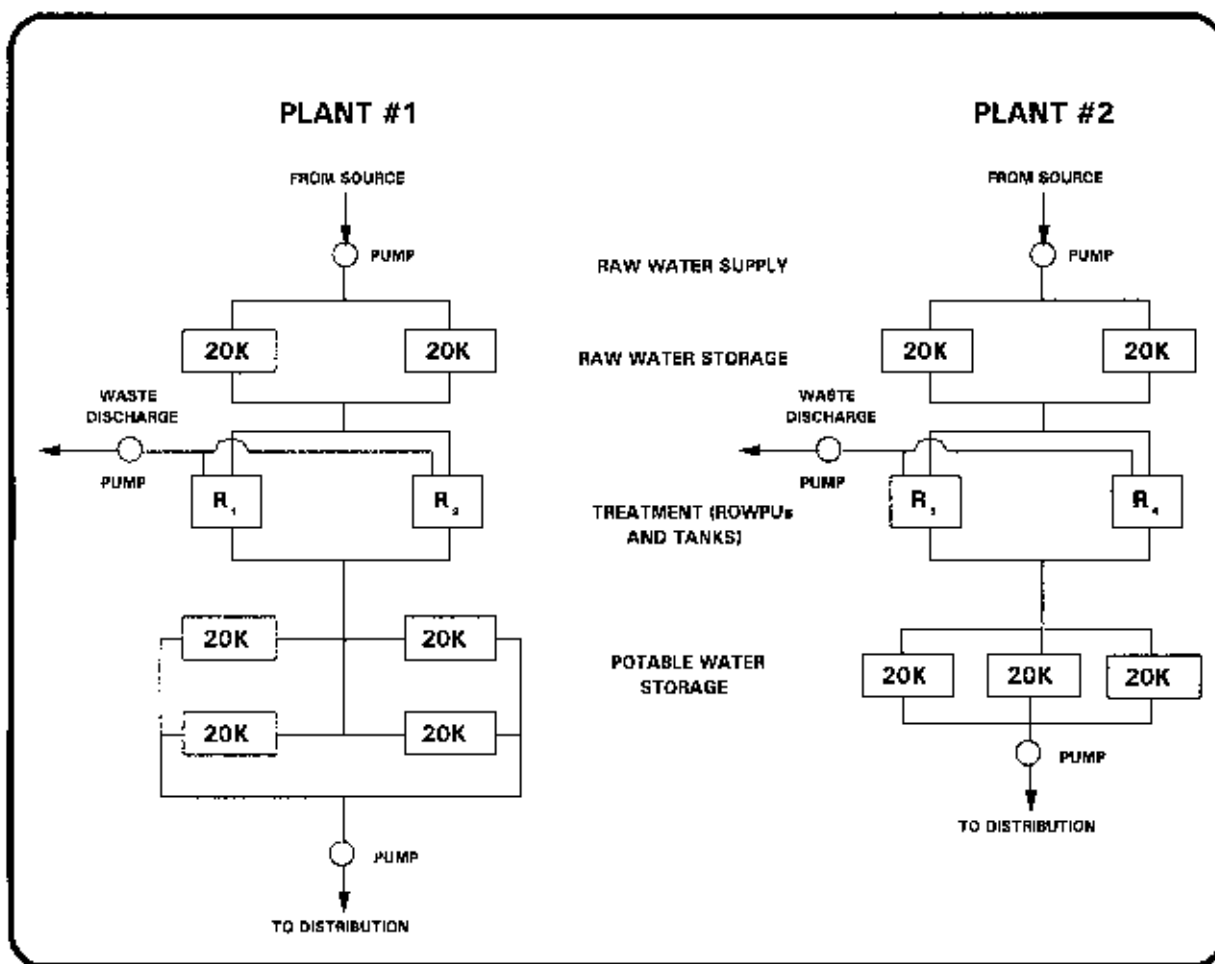


Figure A9.3. Typical Water Treatment Plants -- 3300-person.

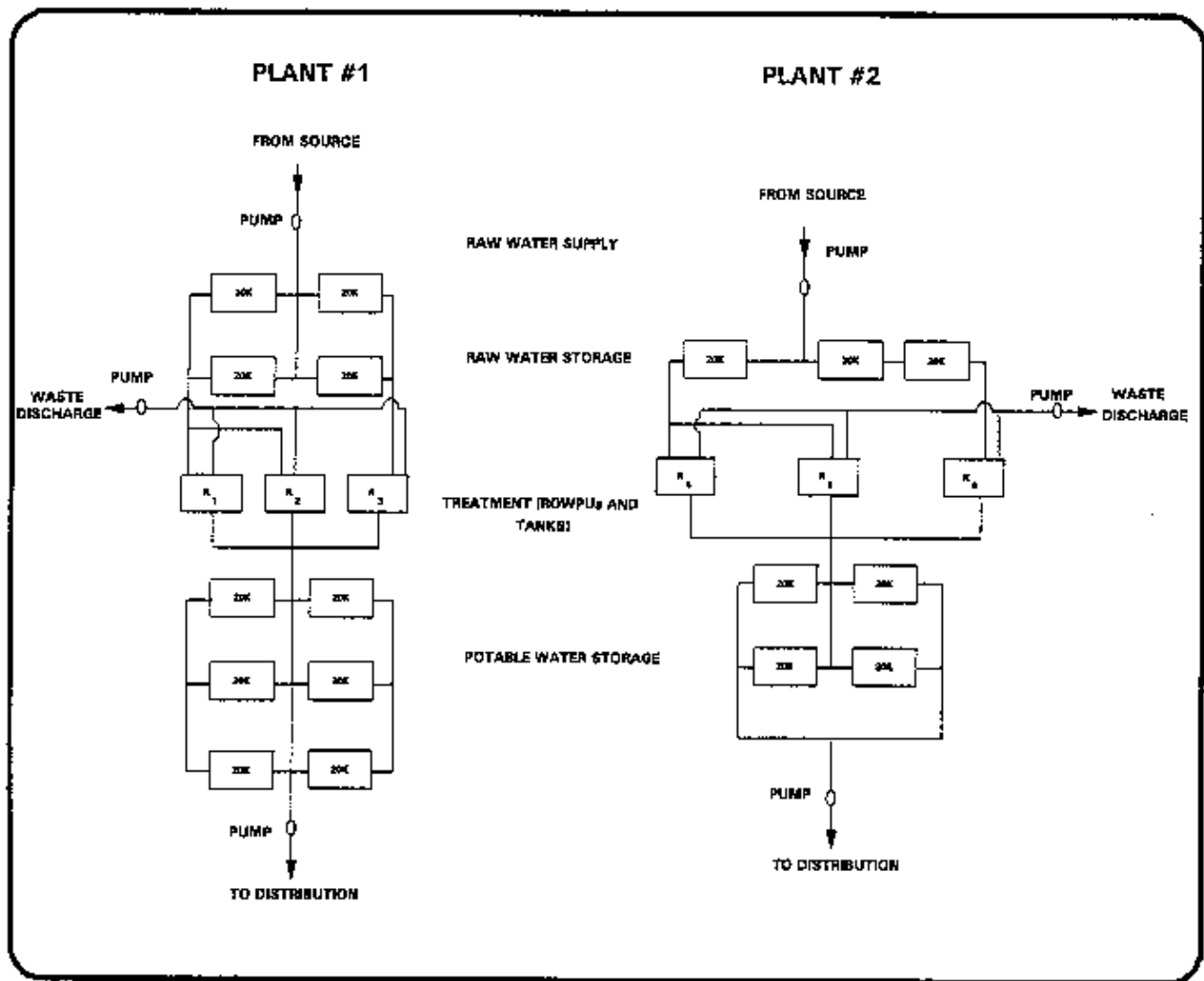


Figure A9.4. Water Plant Detail.

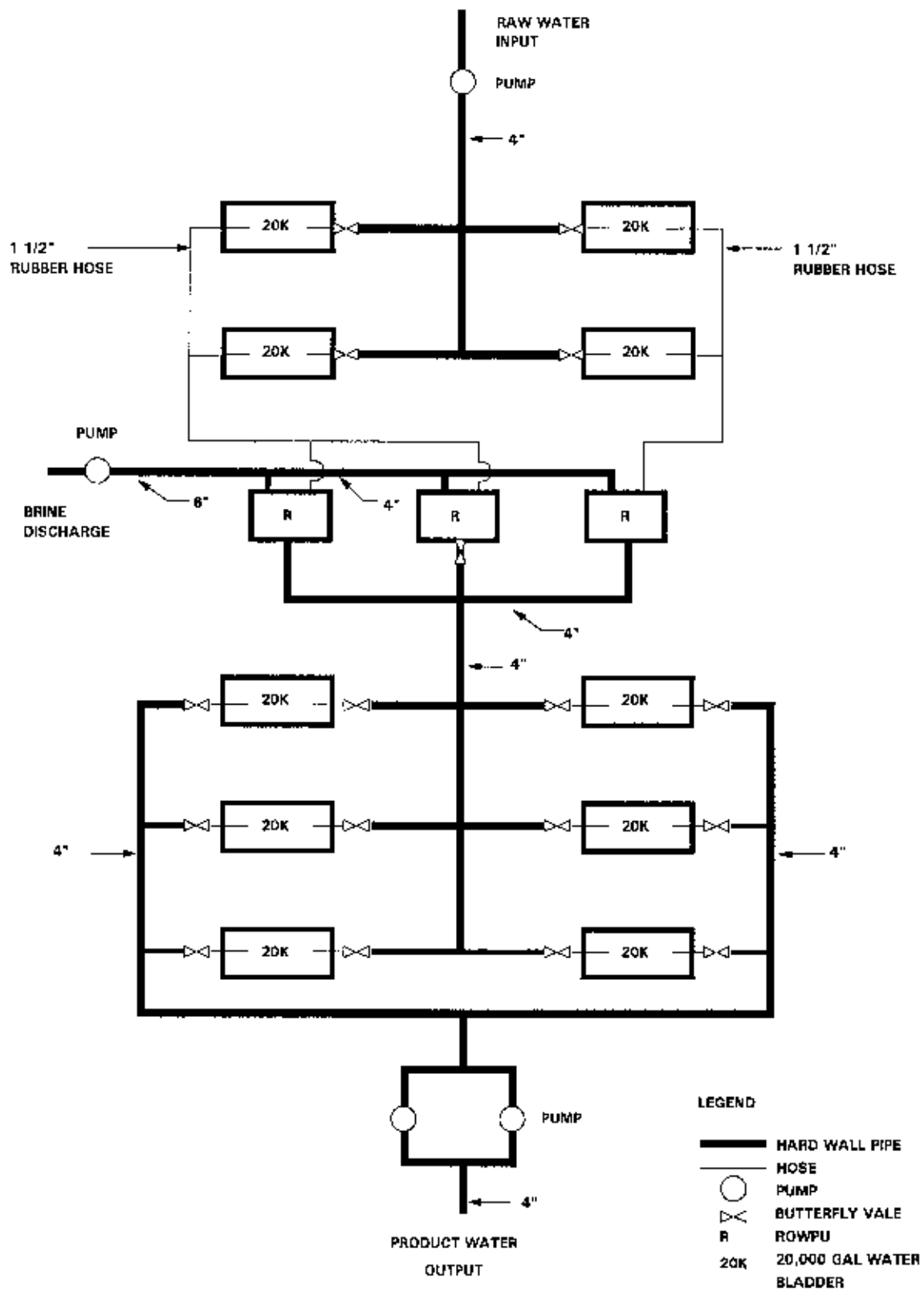


Figure A9.5. Water Plant Detail -- Typical Key.

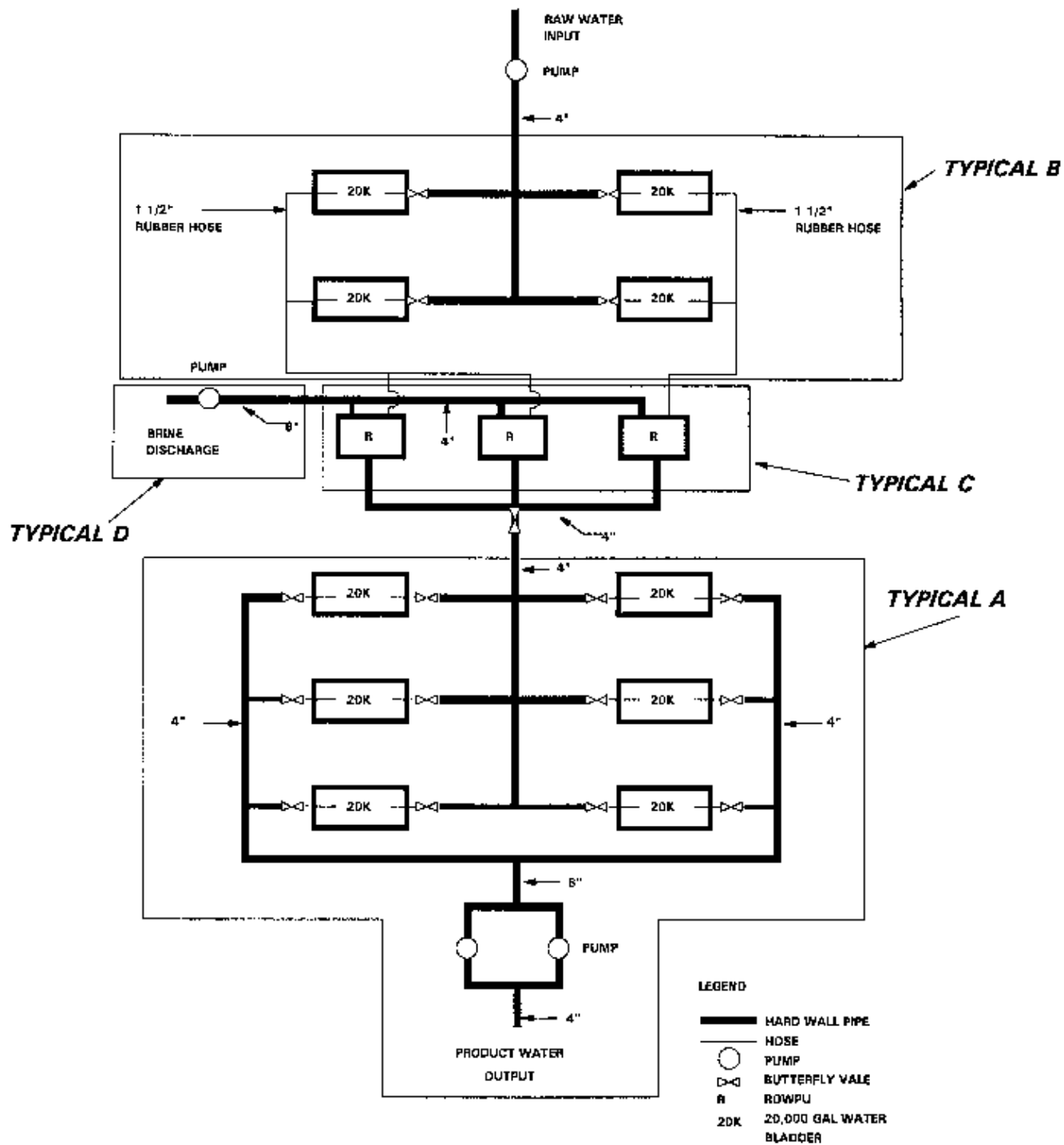


Figure A9.6. Water Plant Detail -- Typical A.

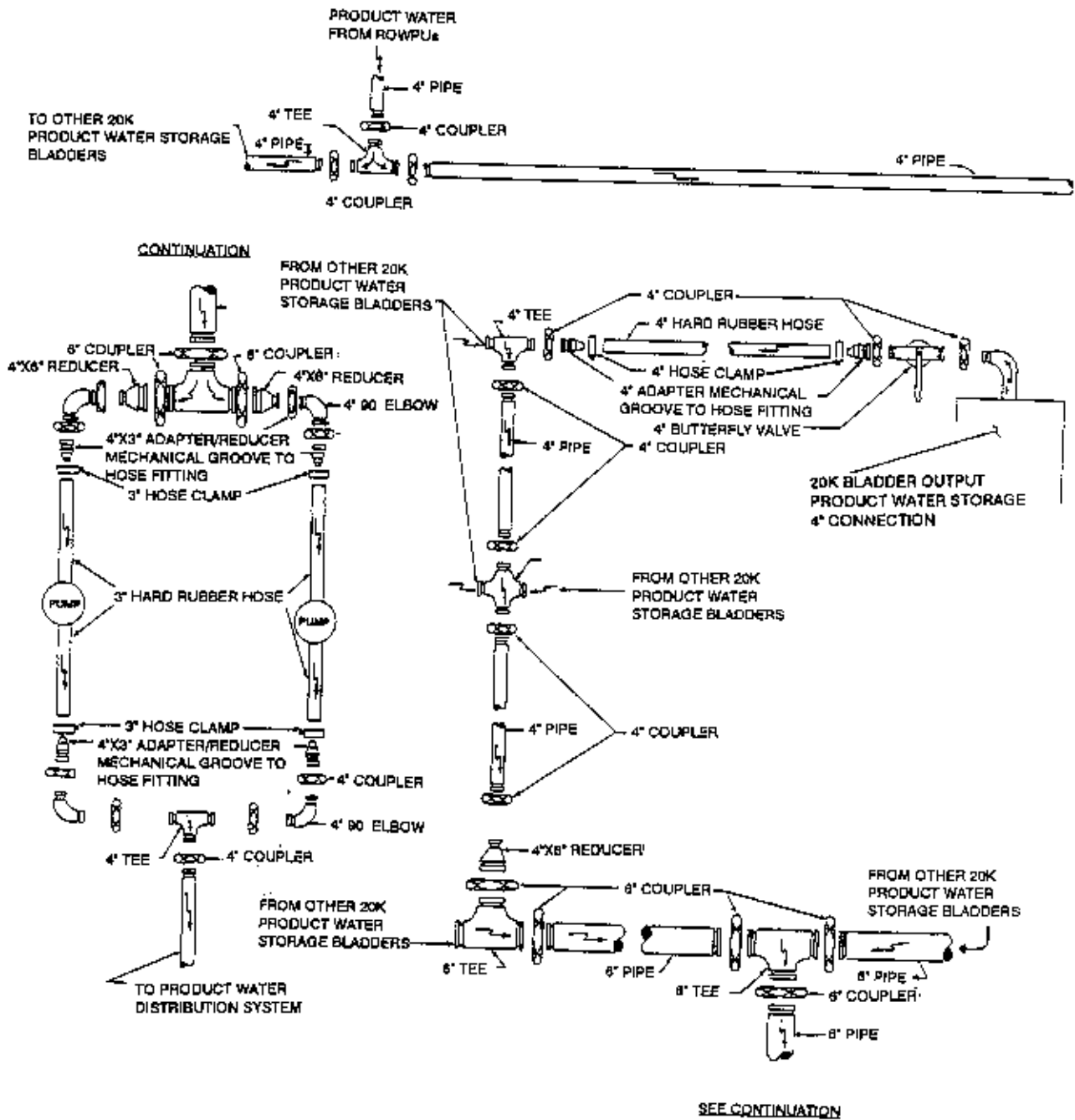
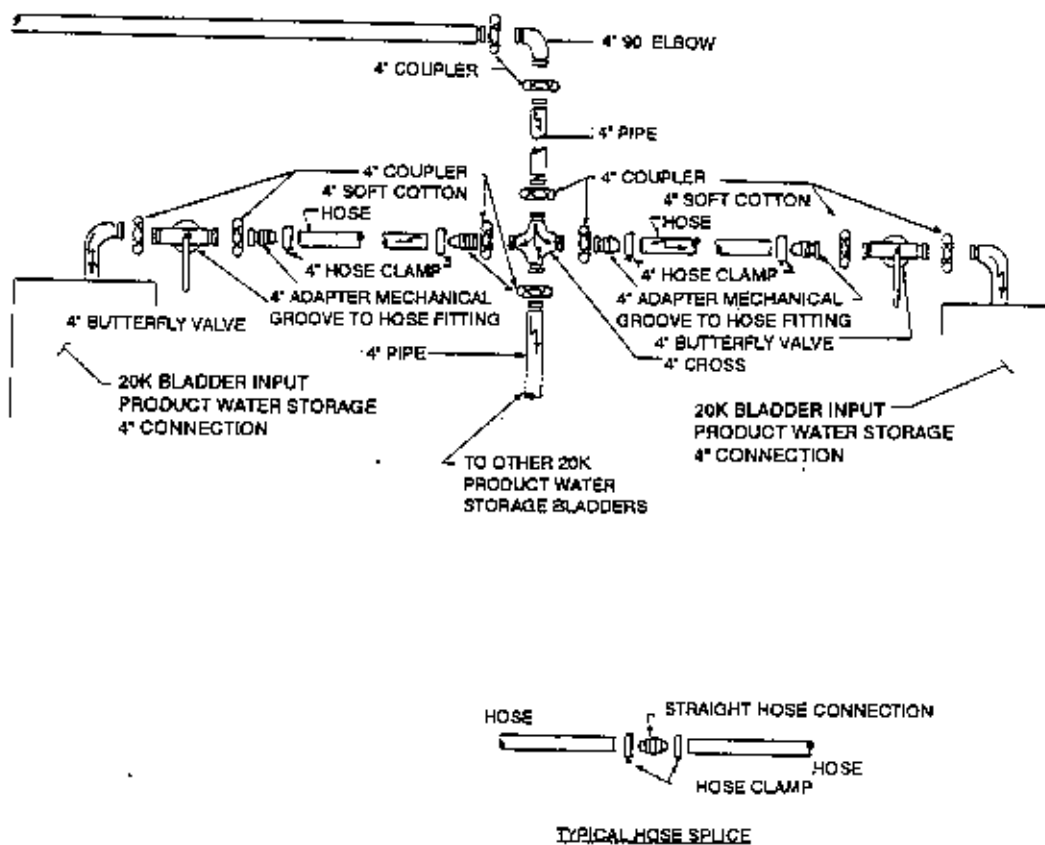
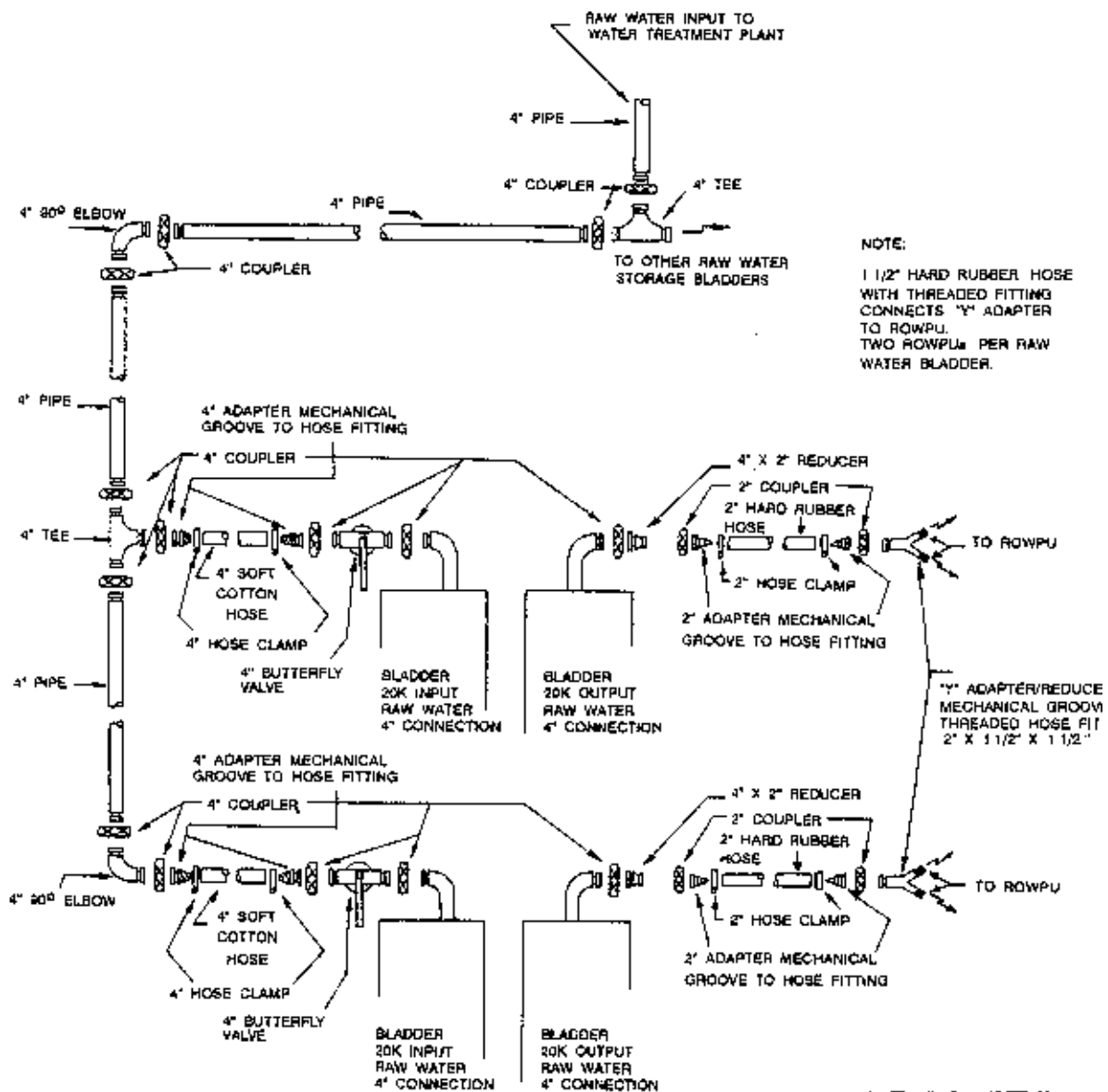


Figure A9.6. Water Plant Detail -- Typical A (continued).



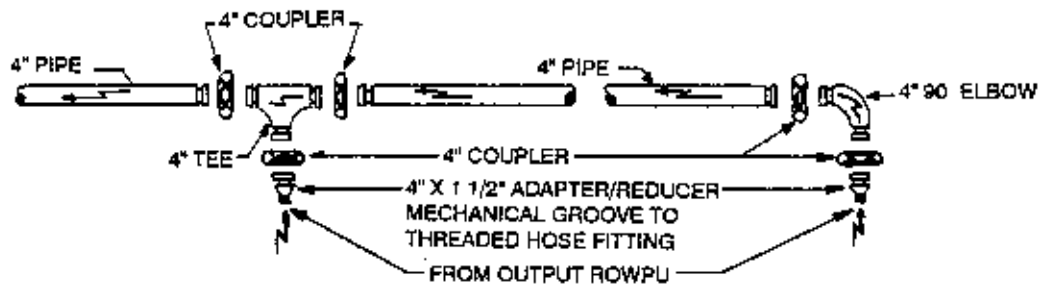
TYPICAL "A"

Figure A9.7. Water Plant Detail -- Typical B.

**TYPICAL "B"**

20K RAW WATER STORAGE BLADDERS
TYPICAL WATER TREATMENT PLANTS

Figure A9.8. Water Plant Detail -- Typical C.

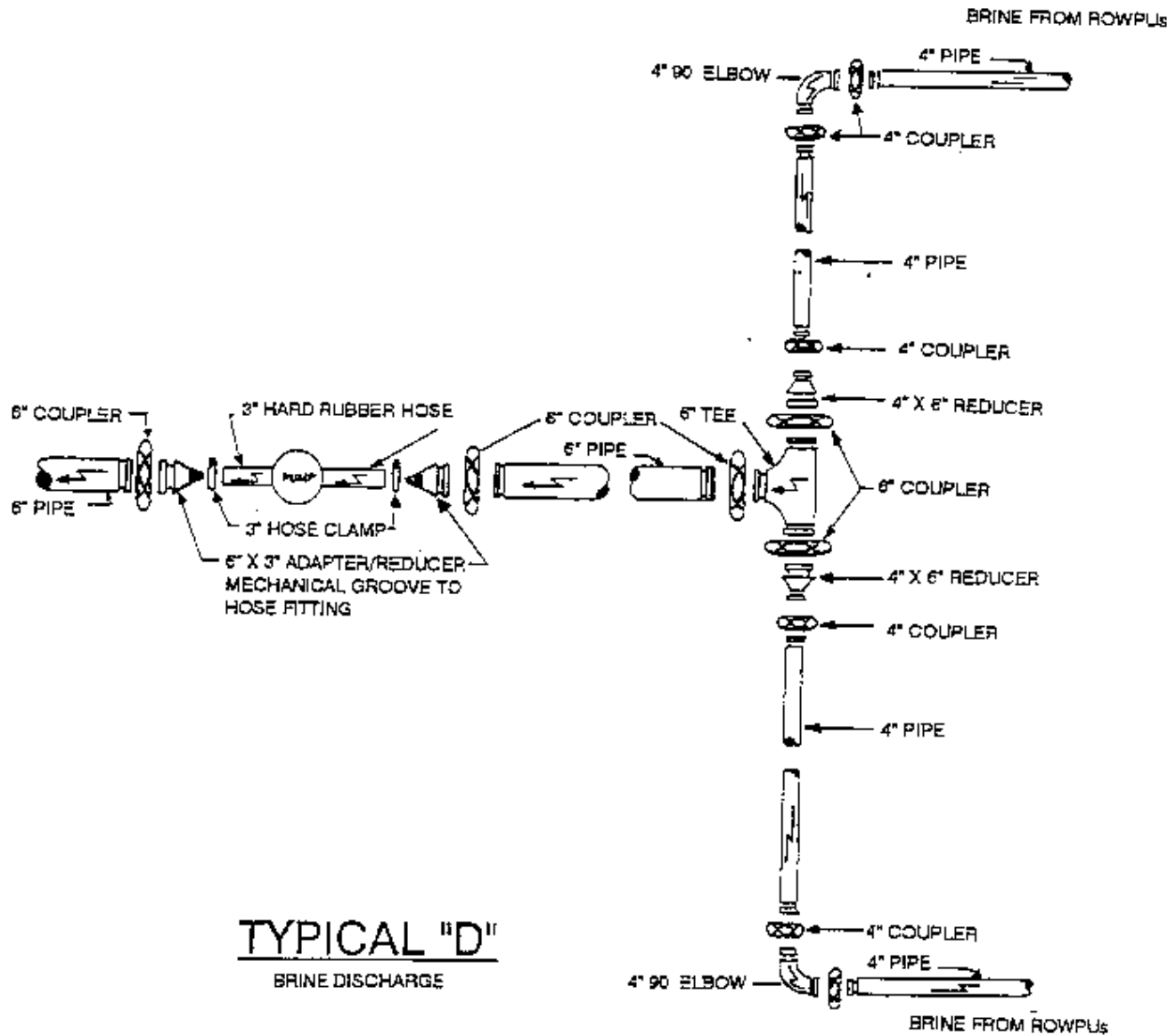


NOTE:
1 1/2" SOFT COTTON HOSE WITH
THREADED FITTINGS CONNECTS
ROWPU TO PRODUCT WATER OR
BRINE LINES

BRINE AND PRODUCT WATER
CONFIGURATION FROM ROWPU
TO DISCHARGE POINT AND
20K PRODUCT WATER
STORAGE BLADDERS RESPECTIVELY

TYPICAL "C"

Figure A9.9. Water Plant Detail -- Typical D.



MAJOR COMPONENT LISTING FOR 550-PERSON HARVEST EAGLE WATER SYSTEM

<u>ITEM</u>	<u>QUANTITY</u>
125 gpm Centrifugal Diesel Pump	6
Bubbler Assembly (electrically operated compressor and aerator)	1
Raw Water Source Suction Hose (noncollapsible hose with strainer, 2" diameter, 50' length)	1
Suction Hose Heat Tracing Kit (heat tape)	1
125 gpm Water Pump Connection Kit--Raw Water (valves, 2" noncollapsible suction hose, 2" collapsible discharge hose, 4" collapsible hose)	1
125 gpm Water Pump Connection Kit--Potable Water (valves; tank connections; fittings; 2" collapsible hose; 4" collapsible hose)	1
10,000-gal Water Tank Connection Kit (valves; 2" collapsible hose)	2
10,000-gal Water Storage Bladders	2
Back Pressure Regulator, 50 gpm flow, 20 psi	2
Hypochlorination Unit, 2 to 350 gpm	1
Water Nozzle Connection Kit (fittings, 1.5" collapsible hoses, valves, hand nozzles, nozzle stands)	6
Loading Station Kit (fittings, valves, hoses, nozzles)	4
Facilities Distribution Kit (2" collapsible hose, fittings, valves)	2

<u>ITEM</u>	<u>QUANTITY</u>
Waste Water Pump Assembly, 35 gpm, 5' head	2
Waste Water Discharge Hose Assembly (fittings, 2" collapsible hose)	1
Water Heater Accessory Kit* (stove pipes, couplings, elbow, stack support)	3
10K System Accessory Kit (hose, valves, fittings)	2
Harvest Falcon Connector Kit (4" and 2" couplings)	2

WATER SYSTEM SUPPORT ITEMS

(must be added for full utility capability)

<u>ITEM</u>	<u>QUANTITY</u>
600 gph ROWPU	1
M-80 Water Heater*	2
TEMPER Tent*	3
400-gal Water Buffalo	3
Lyster Bag	12
Collapsible Water Tank, 3,000-gal	8
Mobile Water Chiller	3
Water Jug, 5-gal	25

* Freeze Protection Item

HARVEST FALCON WATER DISTRIBUTION SYSTEM

The following figures depict simplified layouts of the Harvest Falcon water distribution system for various sizes of bare base populations. Pipe lengths were not defined since system layout will be site specific at every installation. Two water treatment plants are established to provide system redundancy, blocks showing facility group locations generally depict dispersed layout conditions and looped distribution networks are used. Figure A11.1 shows the incoming raw water piping system; note that dispensing capability was provided for firefighting and vehicle maintenance purposes. Figures A11.2 through A11.4 illustrate typical water distribution systems for 1,100-, 2,200-, and 3,300-person installations. Figures A11.5 through A11.9 depict various details of typical water system connections.

Figure A11.1. Raw Water Distribution.

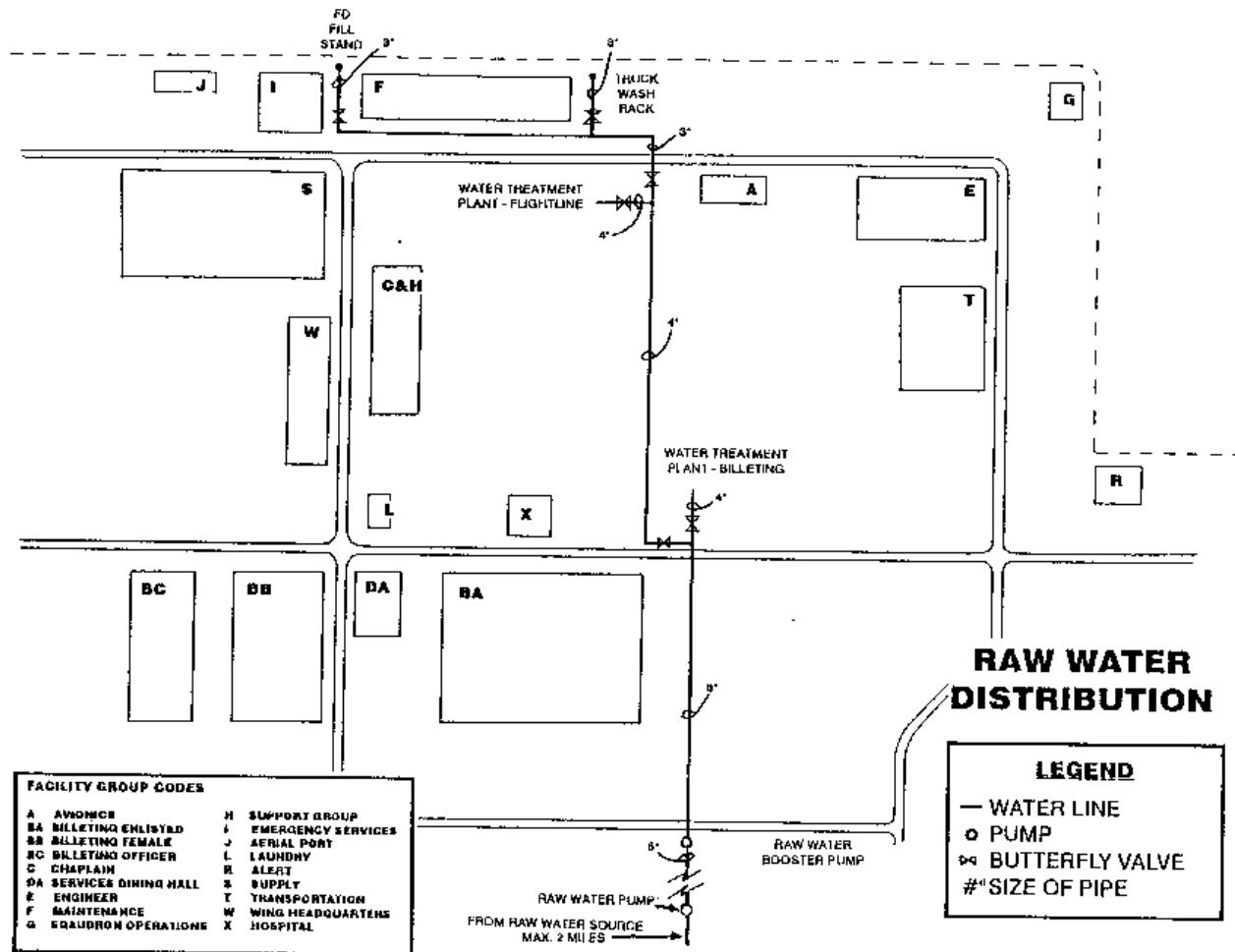
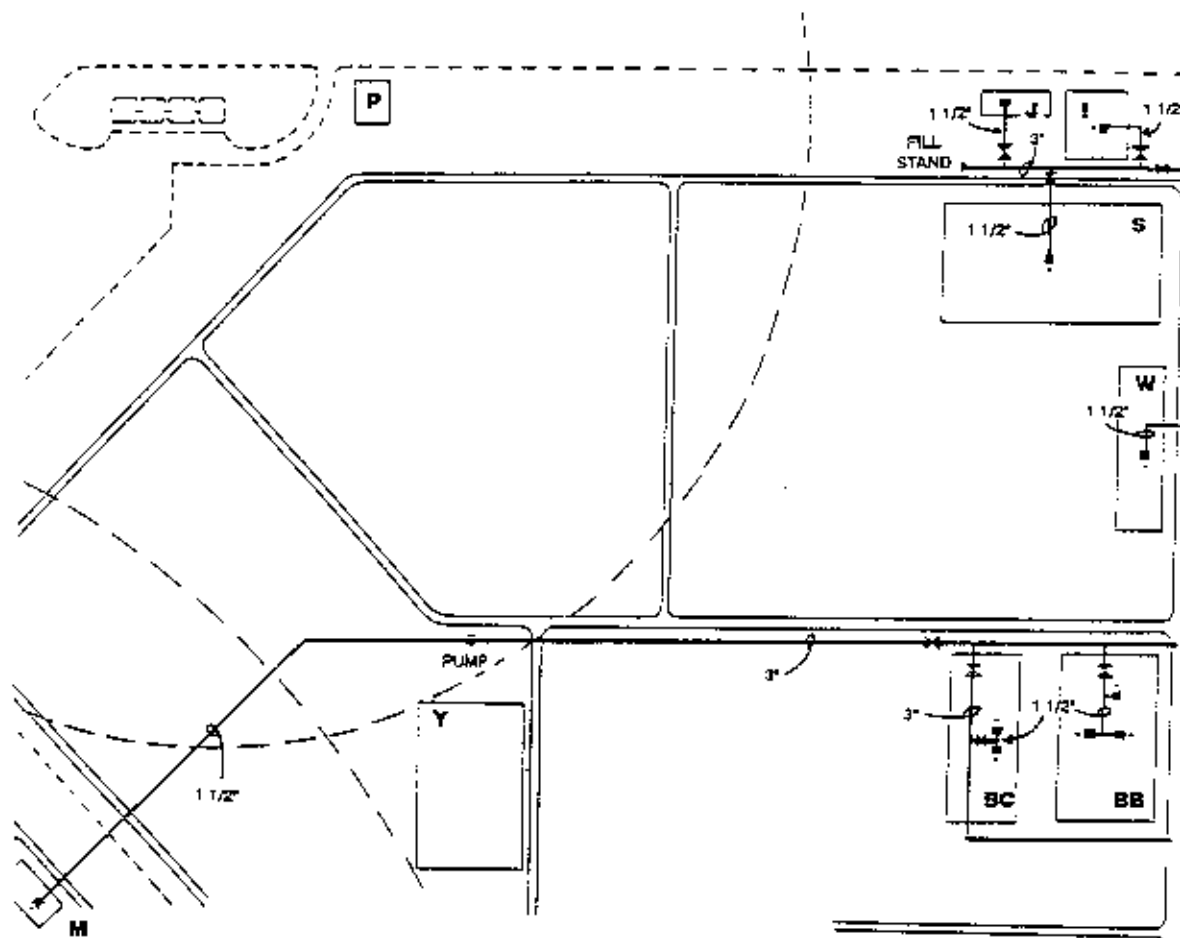


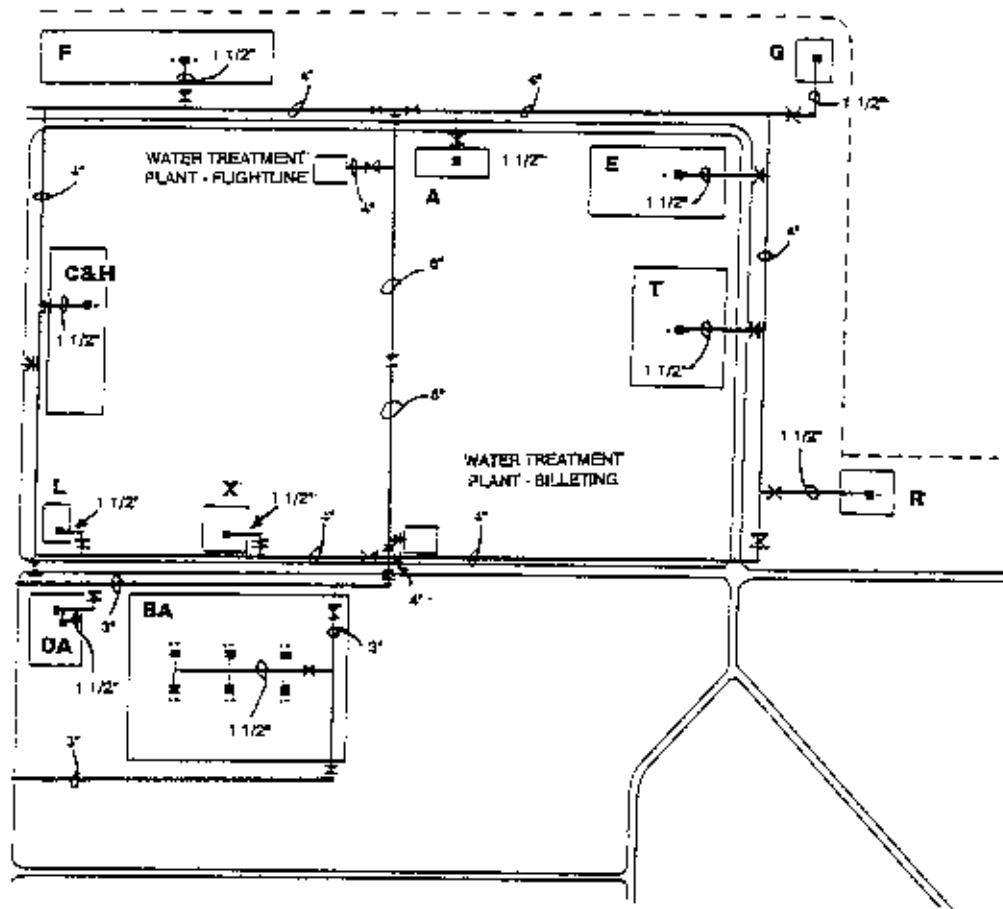
Figure A11.2. Water Distribution System - 1,100-person.



**TYPICAL WATER
DISTRIBUTION LAYOUT
1,100 PERSON**

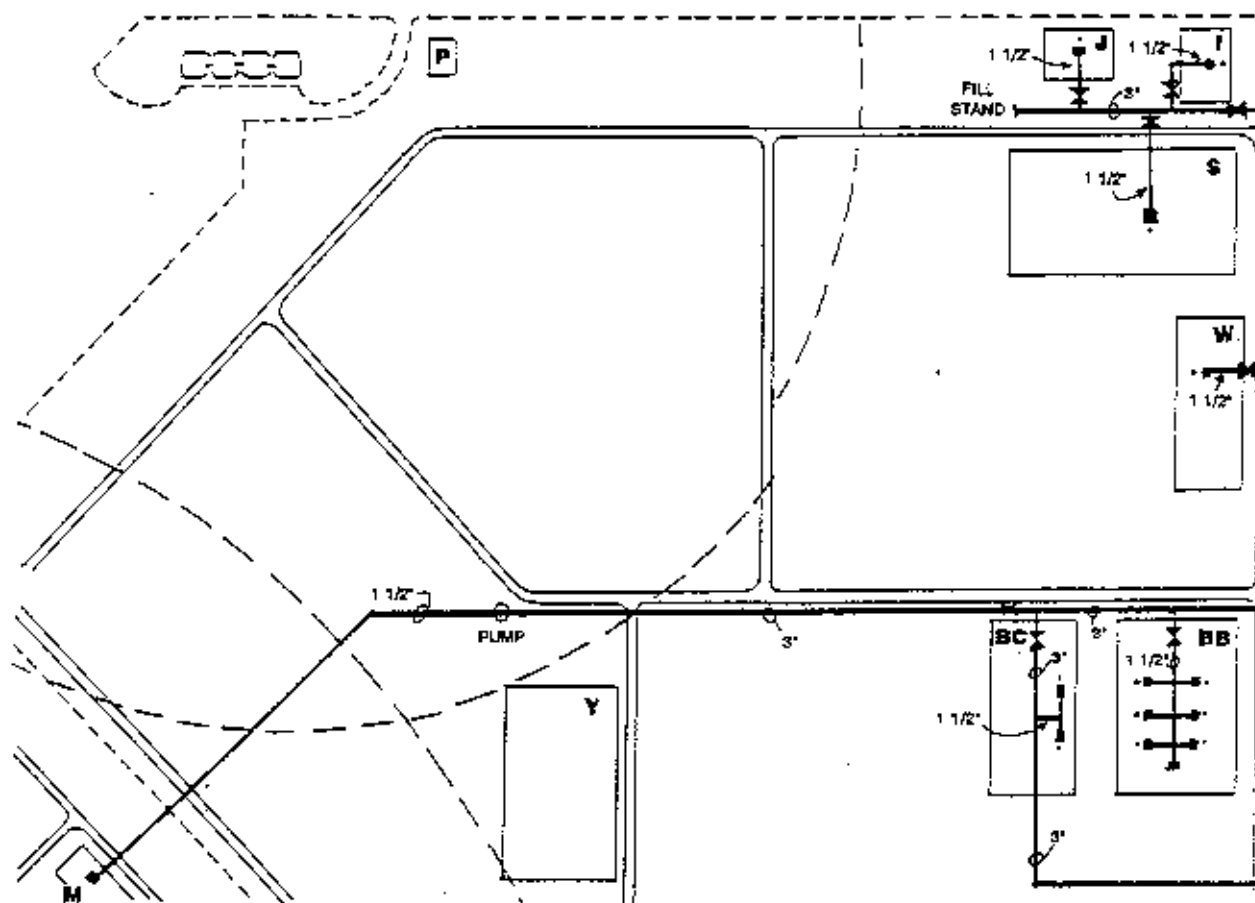
FACILITY GROUP CODES			
A	AVIONICS	J	AERIAL PORT
BA	BILLETING MALE	L	LAUNDRY
BB	BILLETING FEMALE	M	MUNITIONS
BC	BILLETING OFFICER	P	POL
C	CHAPLAIN	R	ALERT
DA	SERVICES DINING HALL	S	SUPPLY
E	ENGINEER	T	TRANSPORTATION
F	MAINTENANCE	W	WING HEADQUARTERS
G	SQUADRON OPERATIONS	X	HOSPITAL
H	SUPPORT GROUP	Y	COMMUNICATIONS
I	EMERGENCY SERVICES		

Figure A11.2. Water Distribution System - 1,100-person (continued).

**LEGEND**

- ✕ BUTTERFLY VALVE
- BUILDING
- FOUNTAIN
- ⌀ PIPE DIAMETER

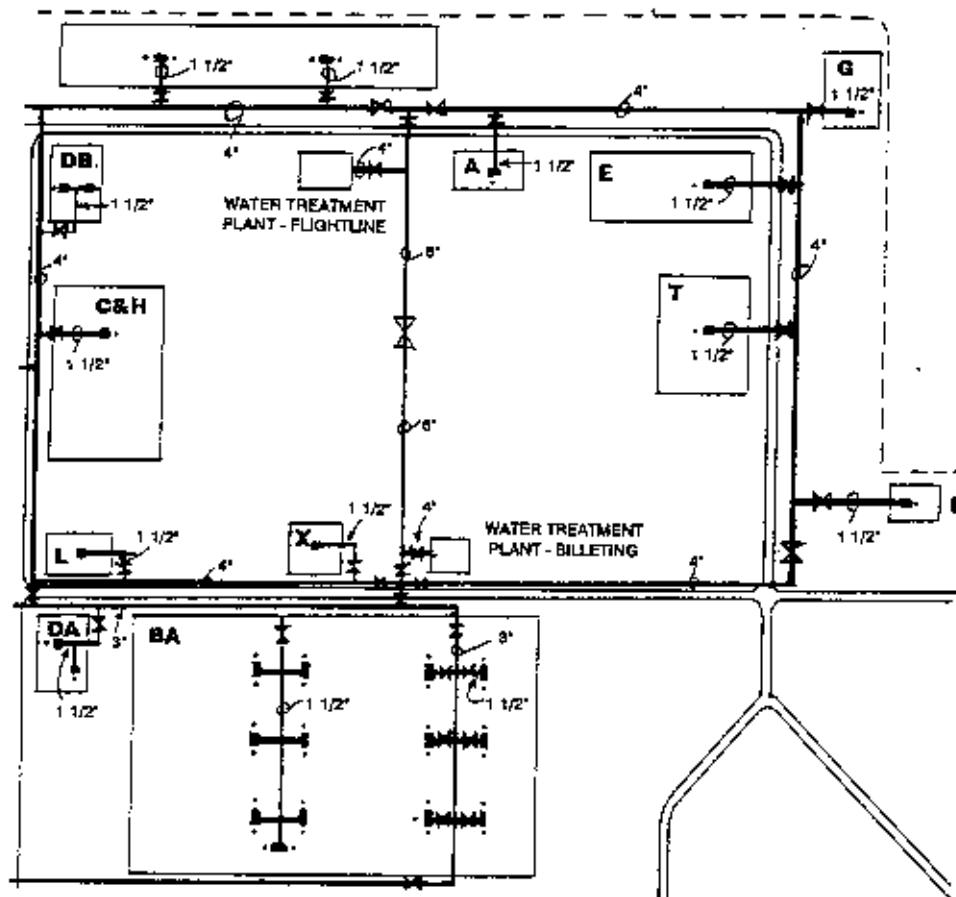
Figure A11.3. Water Distribution System - 2,200-person.



**TYPICAL WATER
DISTRIBUTION LAYOUT
2,200 PERSON**

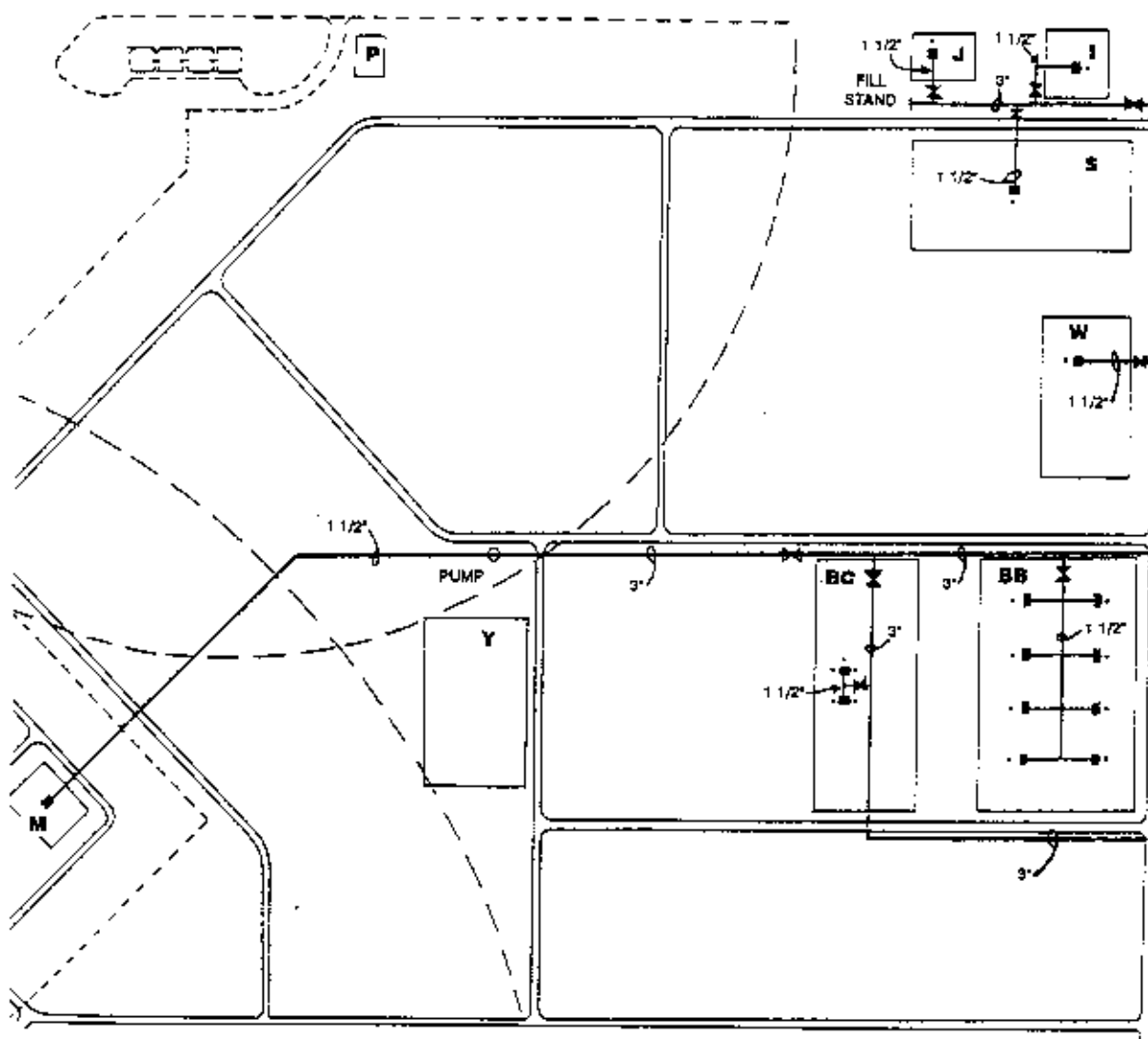
FACILITY GROUP CODES	
A	AVIONICS
BA	BILLETING ENLISTED
BB	BILLETING FEMALE
BC	BILLETING OFFICER
C	CHAPLAIN
DA	SERVICES DINING HALL
DB	SERVICES DINING HALL
E	ENGINEER
F	MAINTENANCE
D	SQUADRON OPERATIONS
N	SUPPORT GROUP
I	EMERGENCY SERVICES
J	AERIAL PORT
L	LAUNDRY
M	MUNITIONS
P	POL
N	ALERT
S	SUPPLY
T	TRANSPORTATION
W	WING HEADQUARTERS
X	HOSPITAL
Y	COMMUNICATIONS

Figure A11.3. Water Distribution System - 2,200-person (continued).

**LEGEND**

- ✕ BUTTERFLY VALVE
- BUILDING
- FOUNTAIN
- # PIPE DIAMETER

Figure A11.4. Water Distribution System - 3,300-person.



TYPICAL WATER DISTRIBUTION LAYOUT 3,300 PERSON

FACILITY GROUP CODES

A	ANTONICS	I	EMERGENCY SERVICES
BA	BILLETING ENLISTED	J	AERIAL PORT
BB	BILLETING FEMALE	L	LAUNDRY
BC	BILLETING OFFICER	M	MUNITIONS
BD	BILLETING ENLISTED	P	POL
C	CHAPLAIN	R	ALERT
DA	SERVICES DINING HALL	S	SUPPLY
DB	SERVICES DINING HALL	T	TRANSPORTATION
E	ENGINEER	W	WING HEADQUARTERS
F	MAINTENANCE	X	HOSPITAL
Q	SQUADRON OPERATIONS	Y	COMMUNICATIONS
H	SUPPORT GROUP		

Figure A11.4. Water Distribution System - 3,300-person (continued).

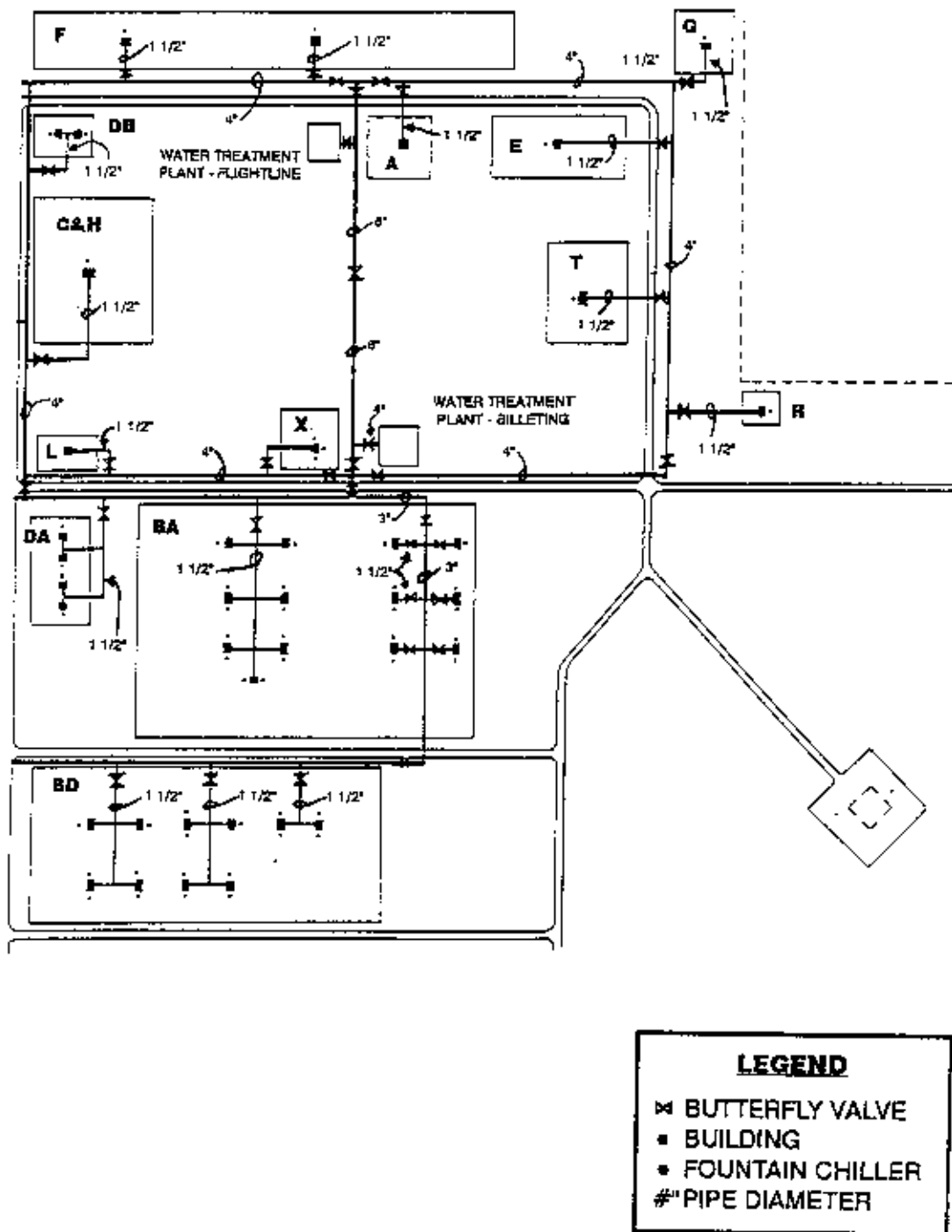
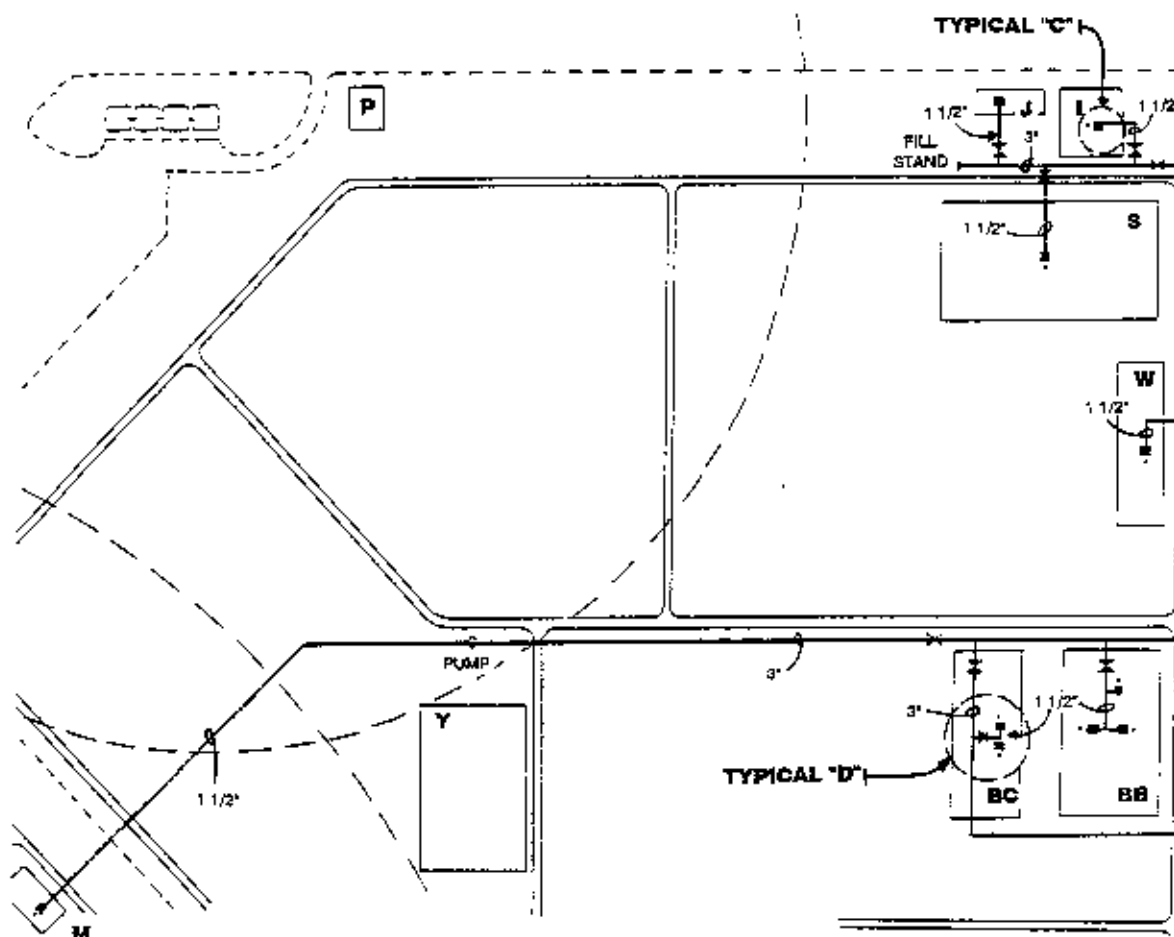


Figure A11.5. Water Distribution Layout - Typical Key.



**WATER
DISTRIBUTION LAYOUT
TYPICAL KEY
1,100 PERSON LAYOUT**

FACILITY GROUP CODES

A	AVIONICS	J	AERIAL PORT
BA	BILLETING MALE	L	LAUNDRY
BB	BILLETING FEMALE	M	MUNITIONS
BC	BILLETING OFFICER	P	POL
C	CHAPLAIN	R	ALERT
DA	SERVICES DINING HALL	S	SUPPLY
E	ENGINEER	T	TRANSPORTATION
F	MAINTENANCE	W	WIND HEADQUARTERS
G	SQUADRON OPERATIONS	X	HOSPITAL
H	SUPPORT GROUP	Y	COMMUNICATIONS
I	EMERGENCY SERVICES		

Figure A11.6. Water Distribution System Detail - Typical A.

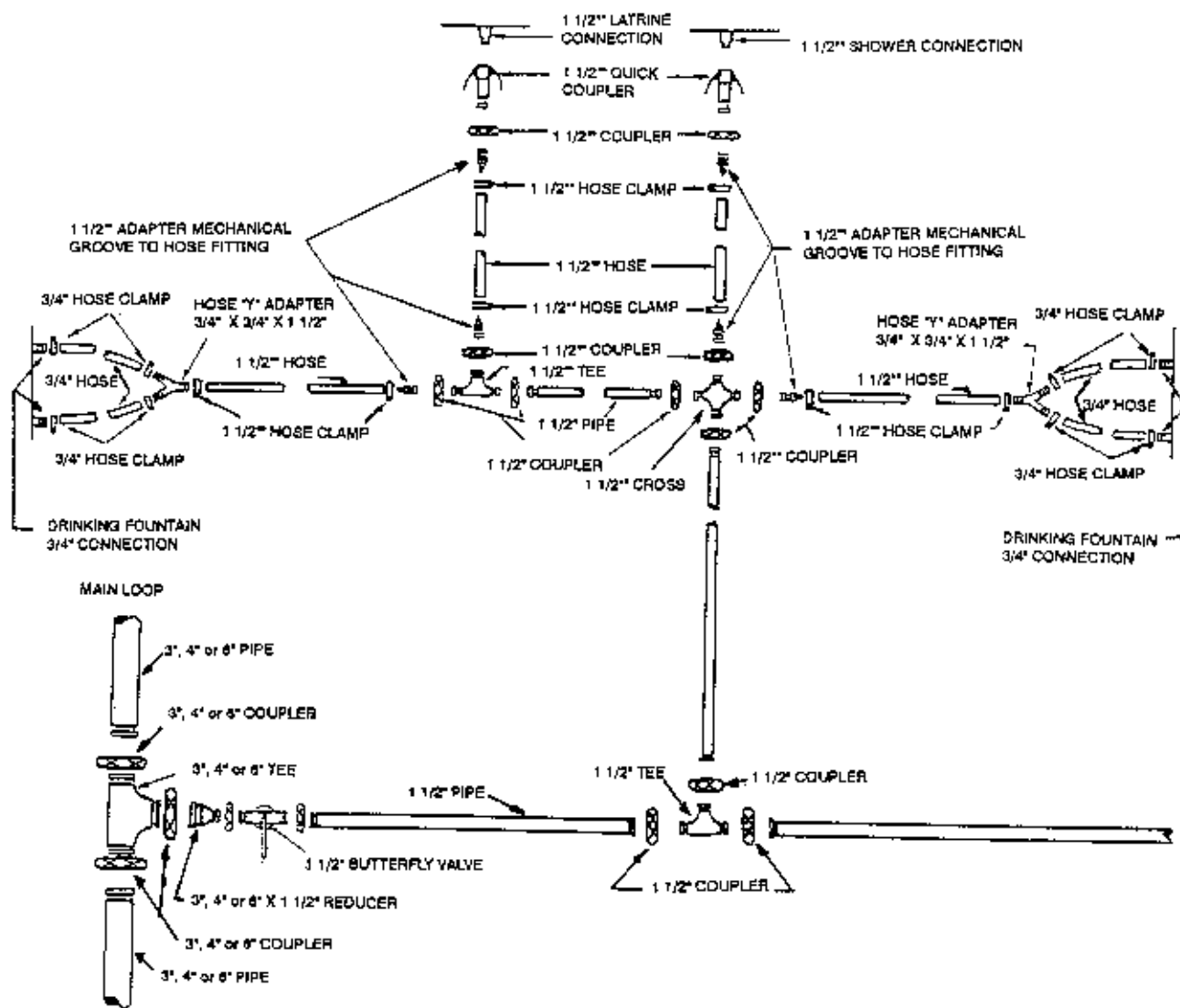
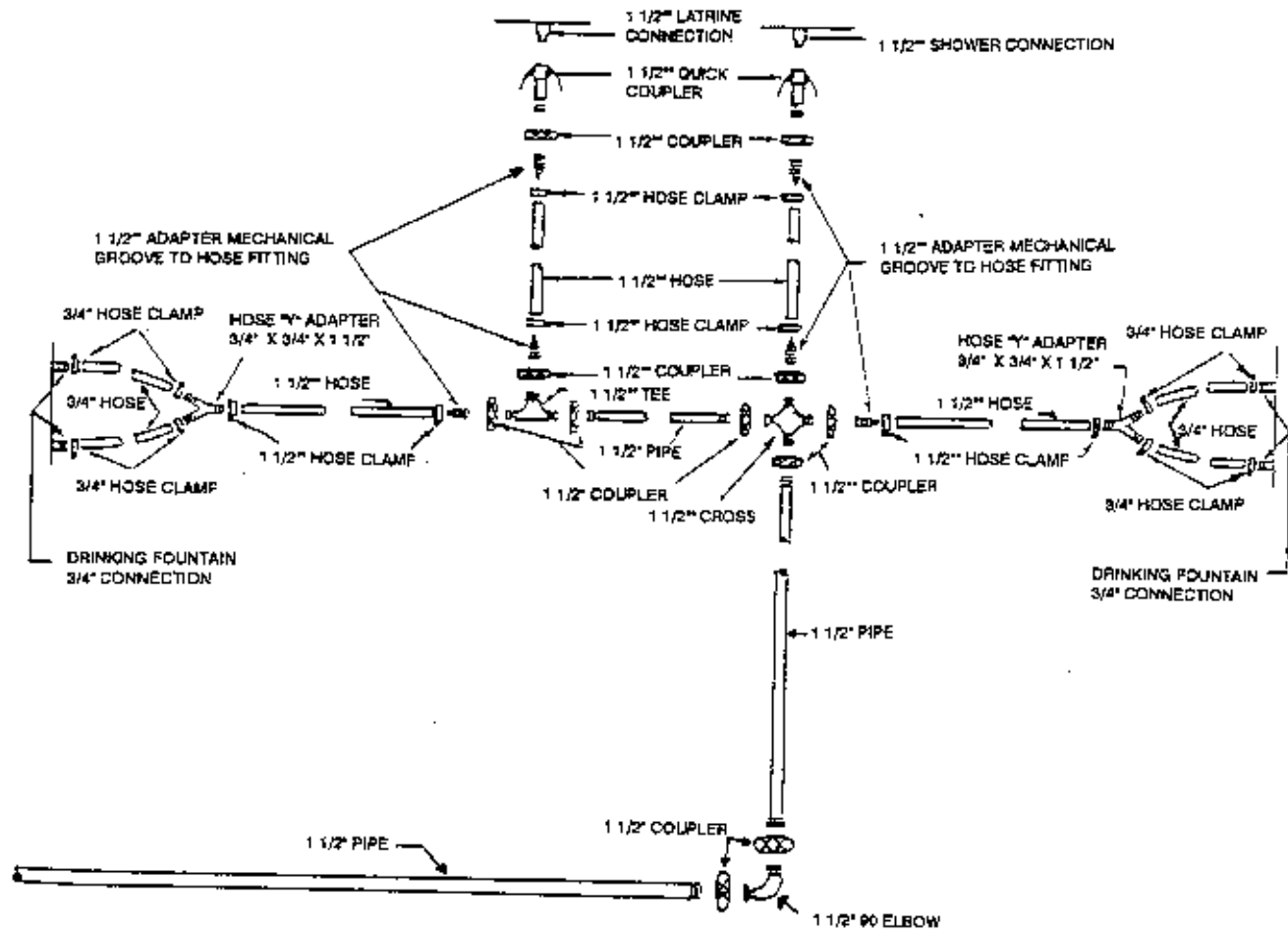


Figure A11.6. Water Distribution System Detail - Typical A (continued).



TYPICAL "A"
 BILLING FOR LATRINES & SHOWERS
 OFF 1 1/2" BRANCH LINES

Figure A11.7. Water Distribution System Detail - Typical B.

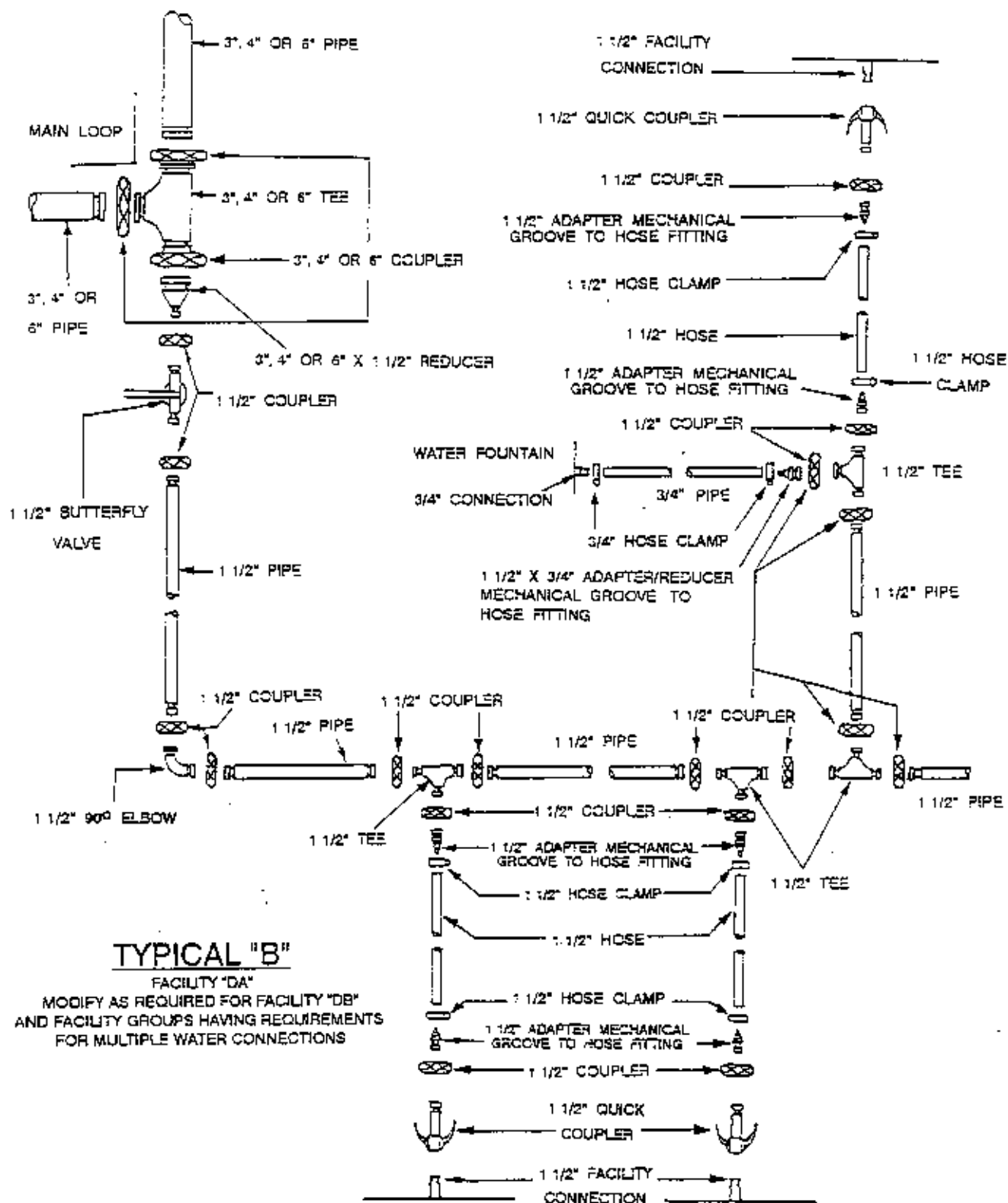


Figure A11.8. Water Distribution System Detail - Typical C.

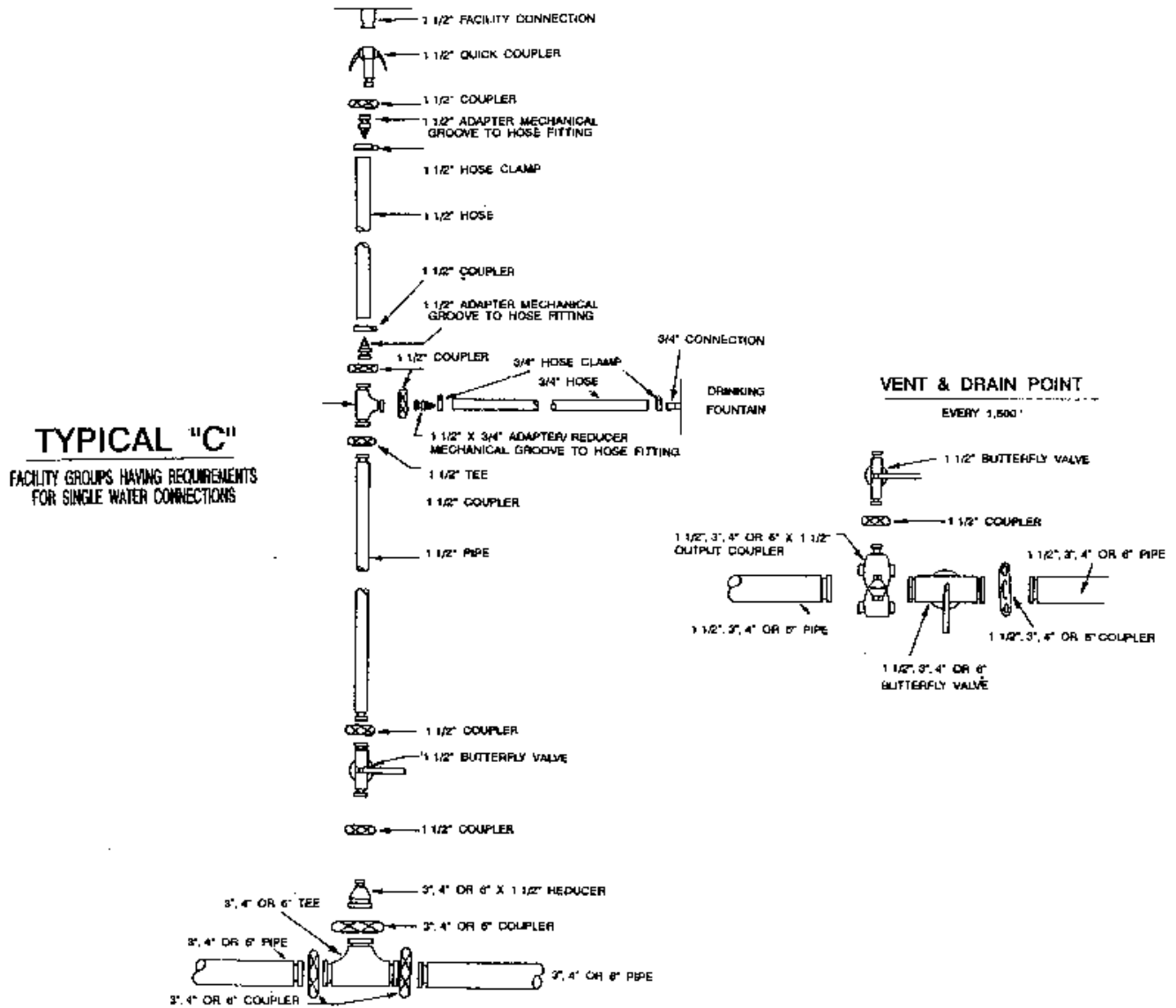
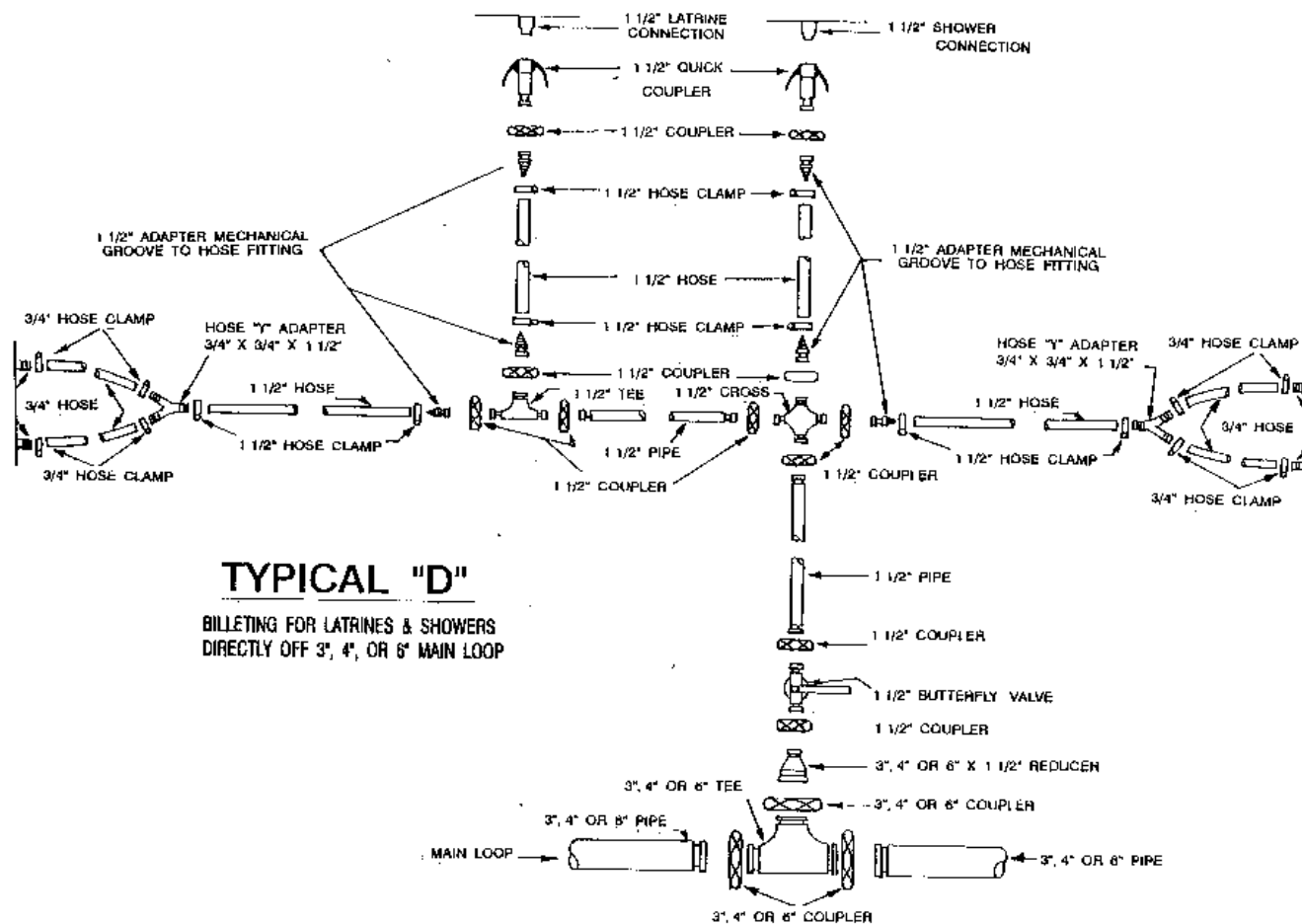


Figure A11.9. Water Distribution System Detail - Typical D.



HARVEST FALCON WASTE COLLECTION SYSTEM

Figures A12.1 through A12.3 depict typical waste collection systems for 1,100-, 2,200-, and 3,300-person bare base installations.

Figure A12.1. Waste Collection Layout - 1,100-person.

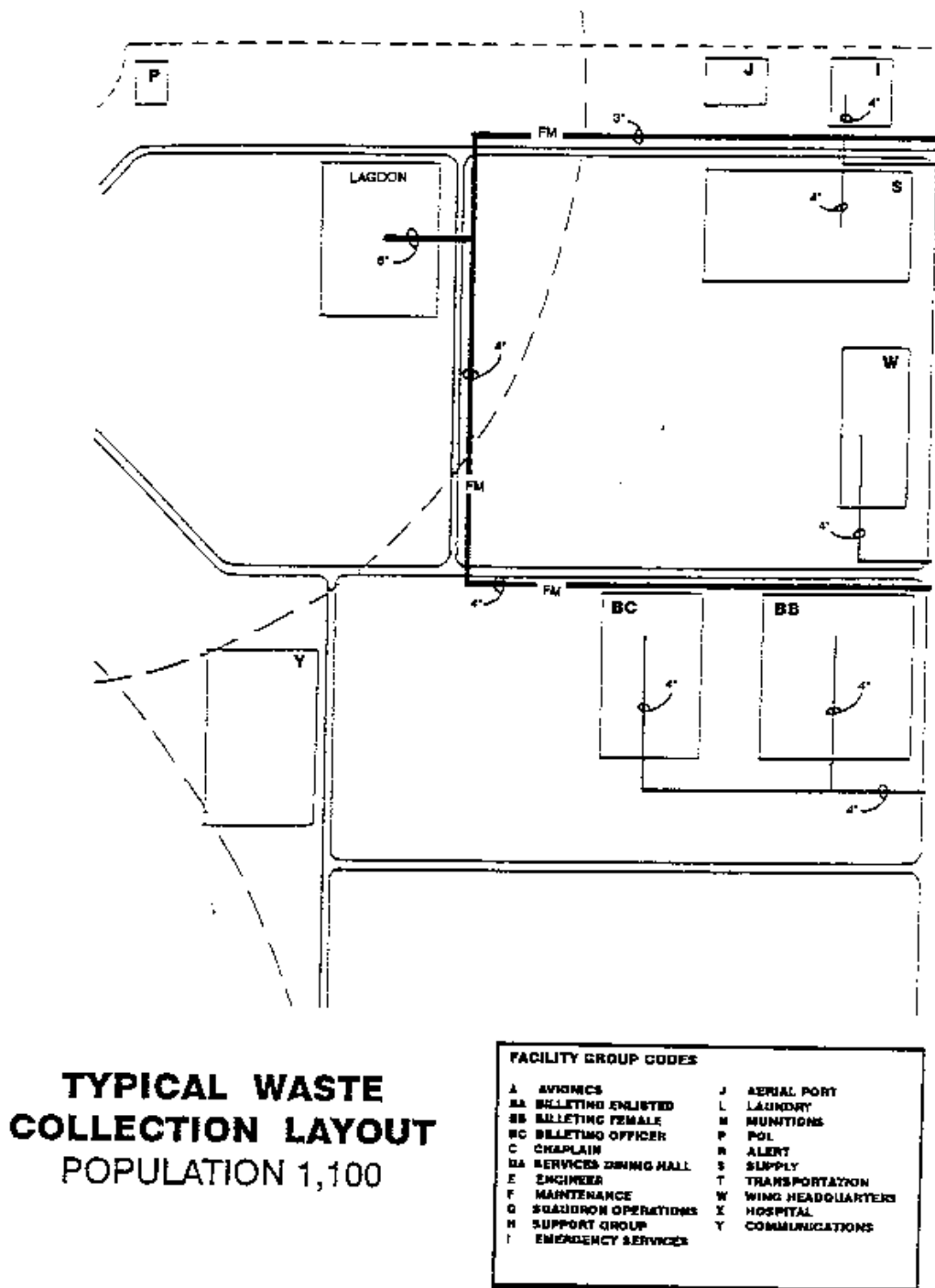


Figure A12.1. Waste Collection Layout - 1,100-person (continued).

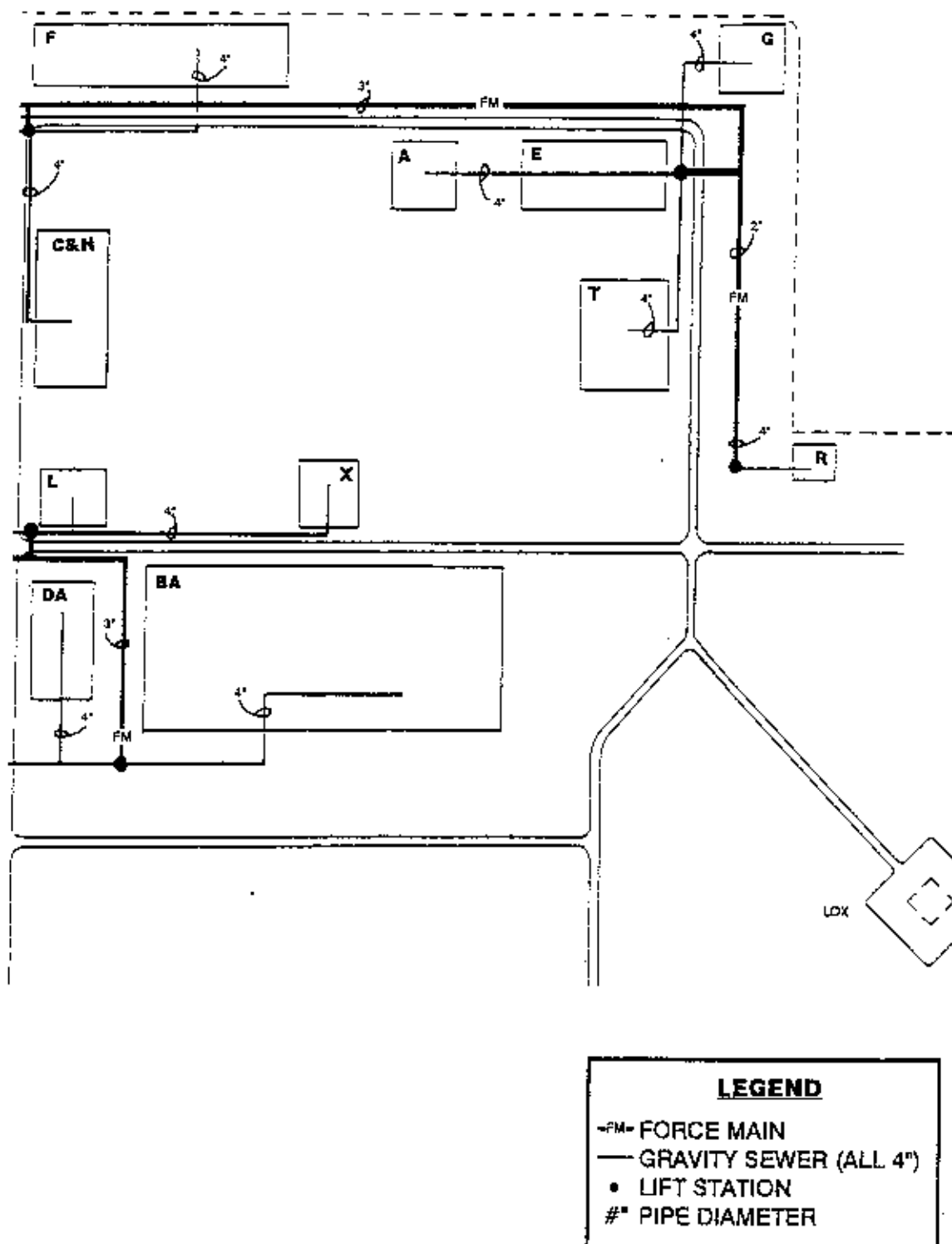
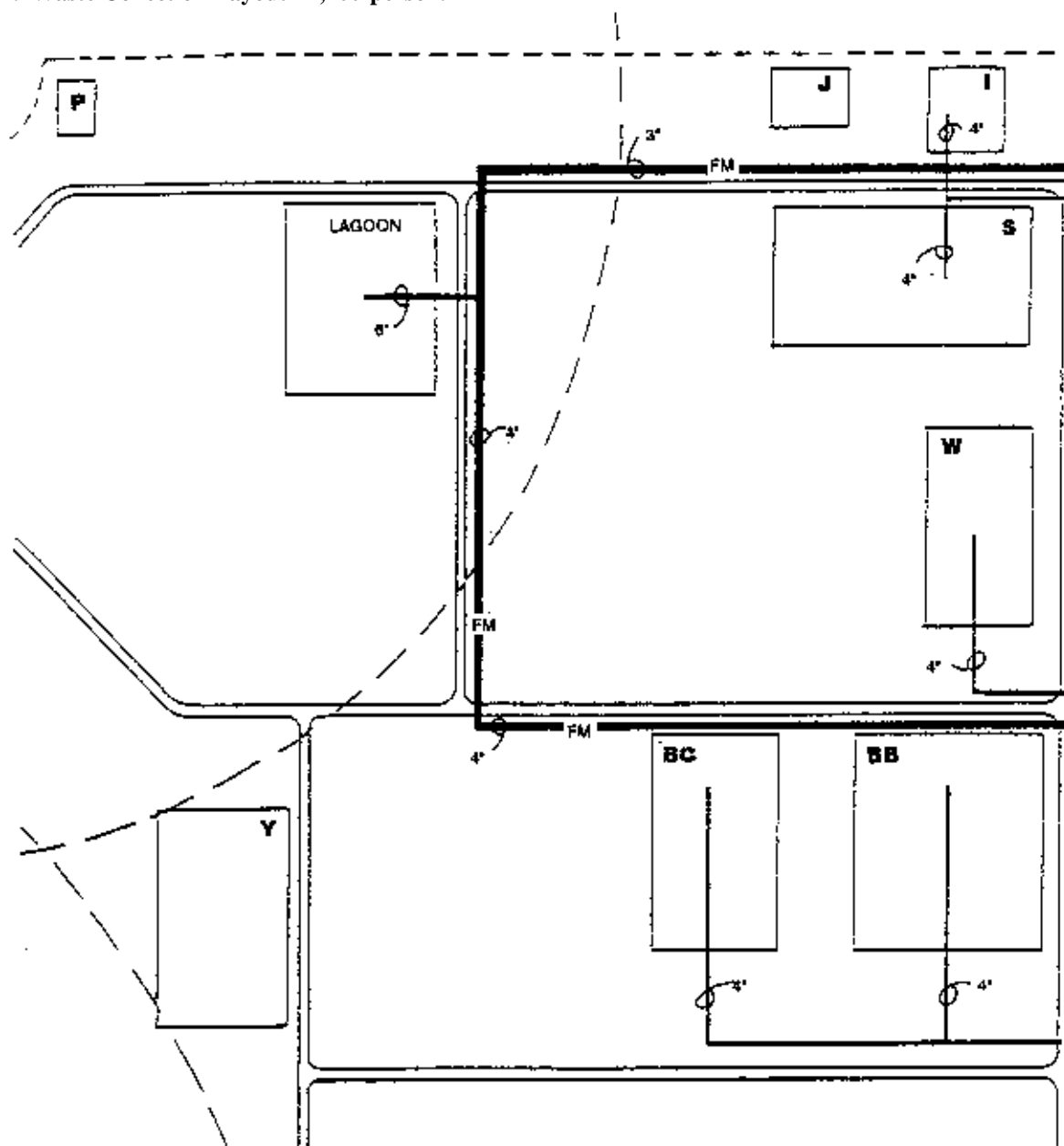


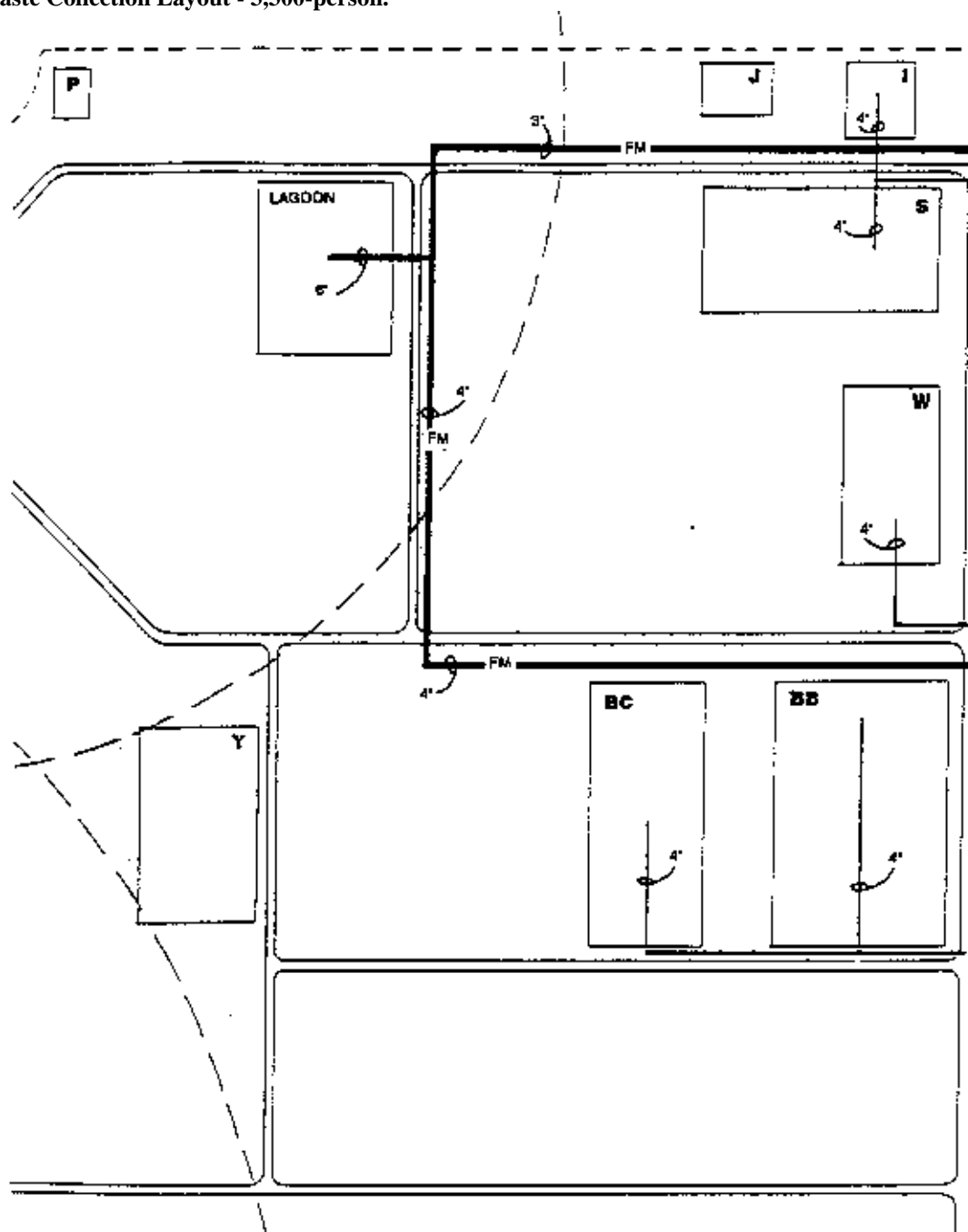
Figure A12.2. Waste Collection Layout - 2,200-person.



TYPICAL WASTE COLLECTION LAYOUT POPULATION 2,200

FACILITY GROUP CODES	
A	AVIONICS
BA	BILLETING ENLISTED
BB	BILLETING FEMALE
BC	BILLETING OFFICER
C	CHAPLAIN
DA	SERVICES DINING HALL
DB	SERVICES DINING HALL
E	ENGINEER
F	MAINTENANCE
Q	SQUADRON OPERATIONS
H	SUPPORT GROUP
I	EMERGENCY SERVICES
J	AERIAL PORT
L	LAUNDRY
M	MUNITIONS
P	POL
R	ALERT
S	SUPPLY
T	TRANSPORTATION
W	WING HEADQUARTERS
X	HOSPITAL
Y	COMMUNICATIONS

Figure A12.3. Waste Collection Layout - 3,300-person.

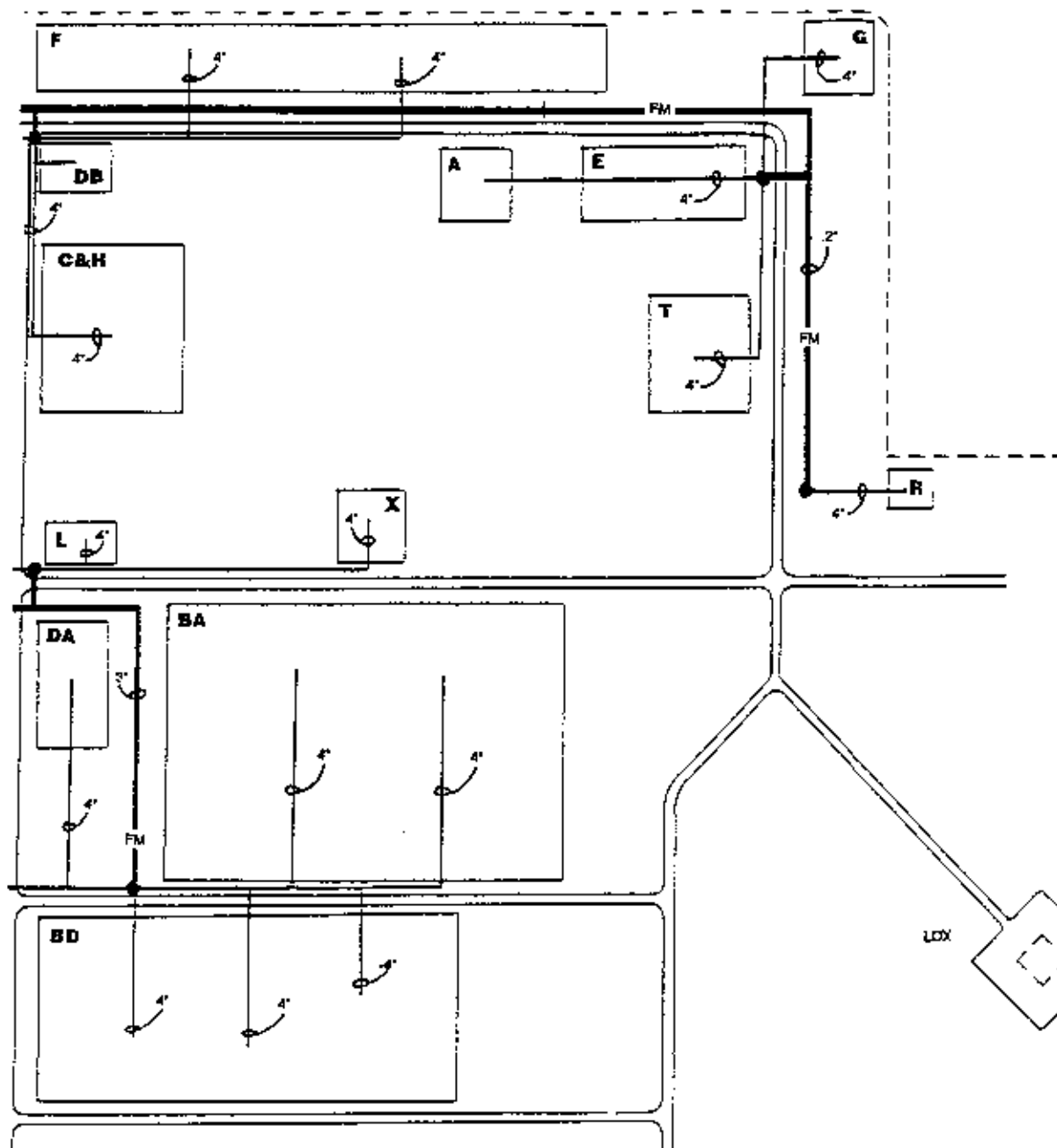


TYPICAL WASTE COLLECTION LAYOUT POPULATION 3,300

FACILITY GROUP CODES

A	AVIONICS	I	EMERGENCY SERVICES
BA	BILLETING ENLISTED	J	AERIAL PORT
BB	BILLETING FEMALE	L	LAUNDRY
BC	BILLETING OFFICER	M	MUNITIONS
BD	BILLETING ENLISTED	P	POL
C	CHAPLAIN	R	ALERT
DA	SERVICES DINING HALL	S	SUPPLY
DB	SERVICES DINING HALL	T	TRANSPORTATION
E	ENGINEER	W	WING HEADQUARTERS
F	MAINTENANCE	X	HOSPITAL
Q	SQUADRON OPERATIONS	Y	COMMUNICATIONS
N	SUPPORT GROUP		

Figure A12.3. Waste Collection Layout - 3,300-person (continued).

**LEGEND**

- FM- FORCE MAIN
- GRAVITY SEWER (ALL 4")
- LIFT STATION
- #" PIPE DIAMETER

HARVEST FALCON FACILITIES MATRIX

FUNCTION	ASSET TYPE	BASE POPULATION		
		1100	2200	3300
Administration	TEMPER	20	36	52
Billeting	TEMPER	94	188	282
Briefing Facilities	TEMPER	2	4	6
Kitchen, 9-1	TEMPER(SET)	1	2	3
Shower/Shave Facility	TEMPER	5	10	15
Latrine	TEMPER	14	22	30
Laundry	TEMPER	2	4	6
Mortuary	TEMPER	2	3	4
General Purpose Facility	GP	14	15	16
Power Pro Facility	ESC	1	2	3
Multipurpose Facility	TEMPER	4	4	4
Common Facility	ESC	8	8	8
Chaplain	TEMPER	1	1	1
Tactical Field Exchange	ESC	2	2	2
Tactical Field Exchange	TEMPER	2	2	2
Combat Supply	ESC	2	2	2
Combat Supply	FSTFS	1	1	1
Modular Structure 8000SF	FSTFS	4	4	4
Modular Structure 4000SF	FSTFS	2	2	2
Vehicle Maint. 4000SF	FSTFS	2	2	2
Pack/Crate 8000SF	FSTFS	1	1	1
Aircrew Alert Facility	TEMPER	3	3	3
Fire Operations	TEMPER	3	3	3
Fuels Lab	ESC	1	1	1
CE Eng Management	TEMPER	2	2	2
CE Utilities	TEMPER	3	5	7
CE Material Management	TEMPER	1	1	1
CE Electric Shop	TEMPER	1	1	1
CE Structures Shop	TEMPER	1	1	1
CE Liquid Fuels Shop	TEMPER	1	1	1
CE HVAC Shop	TEMPER	1	1	1
CE Pest Management Shop	TEMPER	1	1	1
CE Disaster Prep. Shop	TEMPER	2	2	2
CE EOD Shop	TEMPER	1	1	1
CE Equipment Shop	GP	1	1	1
CE Power Pro Shop	GP	1	1	1

FUNCTION	ASSET TYPE	BASE POPULATION		
		1100	2200	3300
Propulsion Shop 8000SF	FSTFS	1	1	1
Propulsion Shop	GP		1	2
Avionics Shop	ESC	1	2	3
Parachute Shop	ESC	1	1	1
Life Support Shop	ESC	1	2	3
Bearing Cleaning Shop	ESC	1	1	1

Electrical Shop	ESC	1	2	3
NDI Lab	ESC	2	2	2
Pneudraulic Shop	ESC	2	2	2
Wheel/Tire Shop	ESC	1	1	1
AGE Shop	GP	2	4	6
Aircraft Hangar	ACH	2	3	4
Water Purification Unit	ROWPU	3	6	9
Initial Water Dist	PIPES/PUMPS (SET)	1	2	3
Water Dist Loop	PUMPS (SET)	1	1	1
Water Dist System	PUMPS/TANKS/PIPES (SET)	1	1	1
	ECU			
Air Conditioners	60KW	234	396	558
Generator	100KW	6	10	14
Generator	750KW	3	6	9
Generator	PDC/SDC/CABLE (SET)	5	9	13
Power Pro System		1	2	3
	TF-1			
Light Cart	REELS	22	42	62
Power Cable Skid	PDC	4	8	12
Primary Dist Center	SDC	1	2	3
Secondary Dist Center	RALS	32	56	80
Remote Area Lighting	10,000 GAL	5	10	15
Fuel Bladder	CALS	2	3	4
Airfield Lighting	BAK-12	1	1	1
Aircraft Barrier	MAAS	1	1	1
Aircraft Barrier	MKT	1	1	1
Mobile Kitchen Trailer	B-2	2	2	2
Revetments	150 LBS	42	42	42
Fire Extinguishers	15KVA	24	42	60
Converter	PACKAGE	1	2	3
Camouflage Net		2	4	6

HARDBACK GP MEDIUM TENT

Bill of Materials		
DESCRIPTION	NO. REQUIRED	REMARKS
A 2 x 6 x 16'-0"	3 ea	Mud Sill
2 x 6 x 15'-6"	3 ea	Mud Sill
B 2 x 4 x 16'-0"	3 ea	Sleeper
2 x 4 x 15'-6"	3 ea	Sleeper
C 2 x 4 x 2'-0"	3 ea	Splice Board
D 2 x 4 x 15'-6"	17 ea	Floor Joist
E 3/4" x 4'-0" x 8'-0"	16 ea	Flooring *1
F 2 x 4 x 16'-0"	2 ea	Side Wall Sill
2 x 4 x 15'-6"	2 ea	Side Wall Sill
G 2 x 4 x 5'-1 1/2"	18 ea	Side Wall Stud
H 2 x 4 x 16'-0"	2 ea	Side Wall Header
2 x 4 x 15'-6"	2 ea	Side Wall Header
J 2 x 6 x 16'-0"	2 ea	Top Plate
2 x 6 x 7'-9"	4 ea	Top Plate
K 2 x 4 x 6'-0 3/4"	4 ea	End Wall Sill
L 2 x 4 x 6'-2"	4 ea	Door Stud
M 2 x 4 x 0'-9 1/2"	4 ea	Nailing Block
N 2 x 4 x 6'-0 3/4"	4 ea	End Wall Header
P 2 x 4 x 5'-1 1/2"	8 ea	End Wall Stud
Q 2 x 4 x 2'-9"	2 ea	Door Header
R 2 x 4 x 5'-11 3/4"	4 ea	Diagonal Rafter
S 2 x 4 x 16'-0"	1 ea	Ridge Board
T 2 x 4 x 8'-11 3/8"	10 ea	Common Rafter
U 2 x 4 x 2'-0"	5 ea	Collar Tie
V 2 x 4 x 11'-9 1/2"	4 ea	Hip Rafter *2
W 2 x 4 x 2'-9"	2 ea	Hip Brace
X 2 x 4 x 6'-11 3/4"	4 ea	End Rafter
Y 2 x 4 x 4'-4"	4 ea	Jack Rafter *2
Z 1/2" x 2'-0" x 8'-0"	4 ea	Side Wall Skirt
1/2" x 2'-0" x 7'-6"	4 ea	Side Wall Skirt
AA 1/2" x 2'-0" x 6'-6"	4 ea	End Wall Skirt
#16 Mesh 4'-0" wide	100 LF	Screen *3
1/2" x 1"	300 LF	Screen Lath *3
Nail 2d	1.0 lb	For Screen Lath
Nail 8d	10.0 lb	
Nail 10d	5.0 lb	
Nail 16d	5.0 lb	
Tent Light Set	1 ea	Harvest Eagle Type
NOTES: *1 Trim after installation to appropriate size. *2 Compound Miters involved in installation. *3 (Not shown on plans) Staples may be used to anchor screen in place until lath can be installed.		

Figure A14.1. Isometric View.

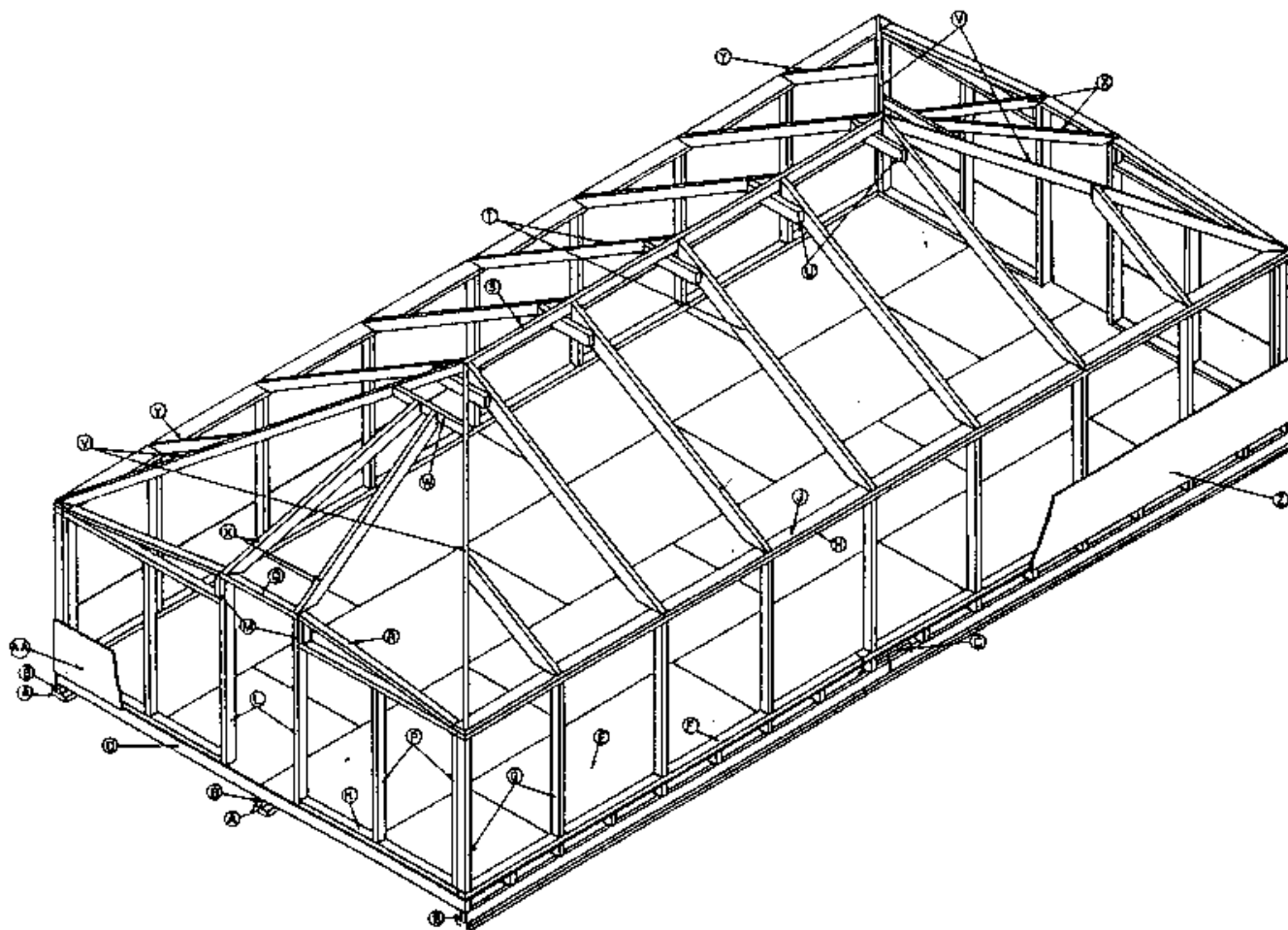


Figure A14.2. Rafter Plan.

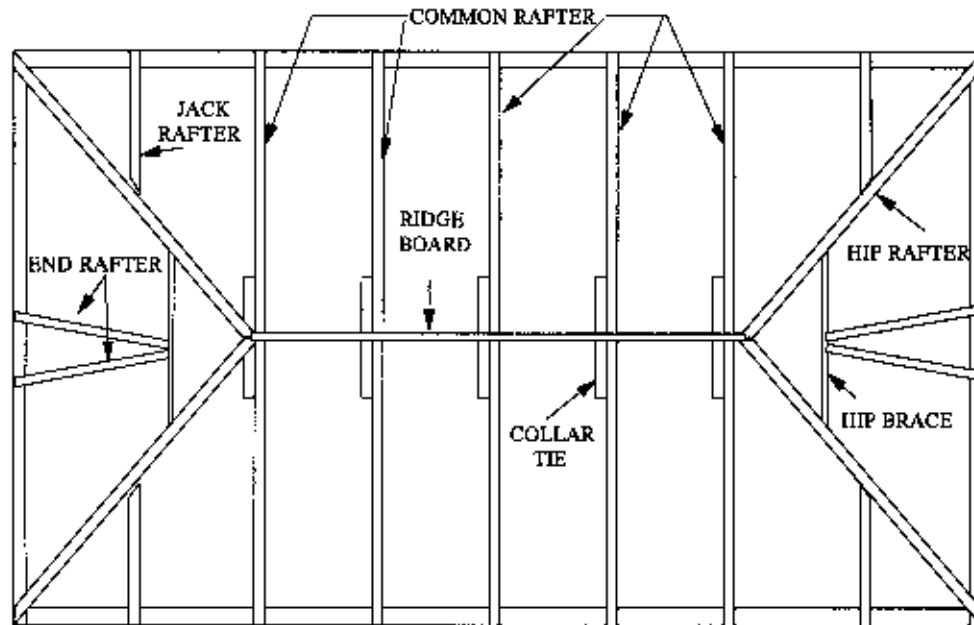


Figure A14.3. End View.

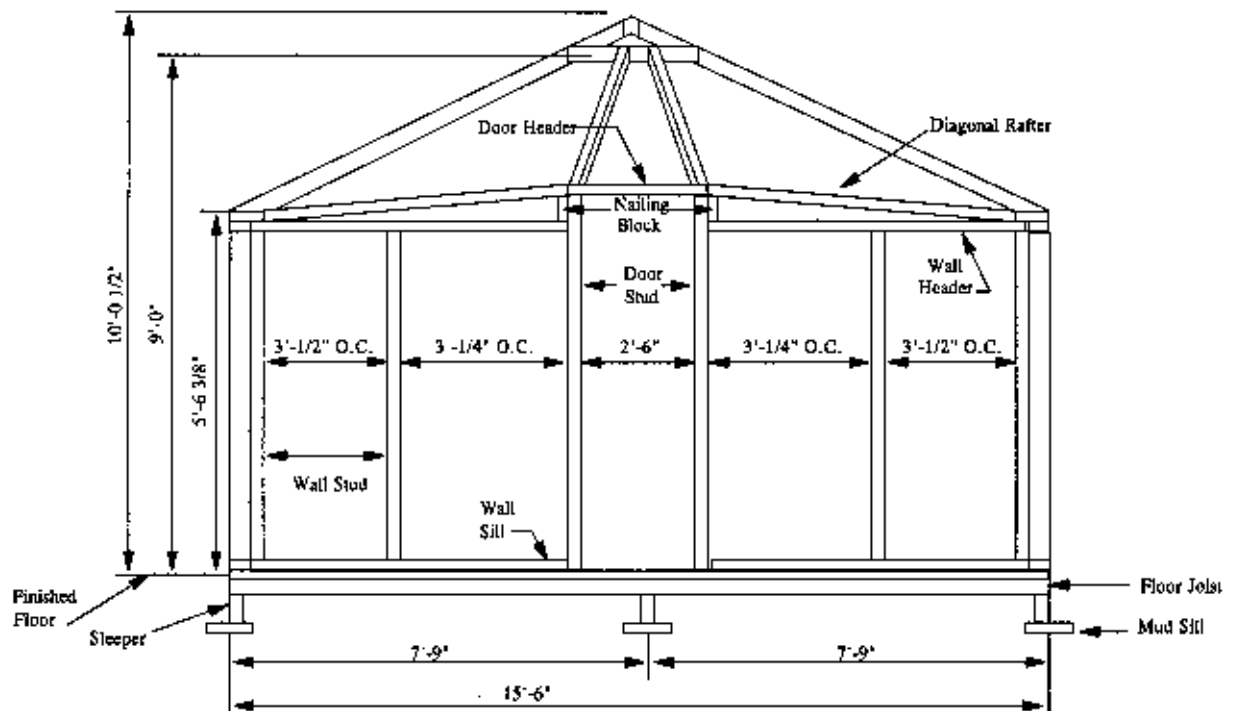
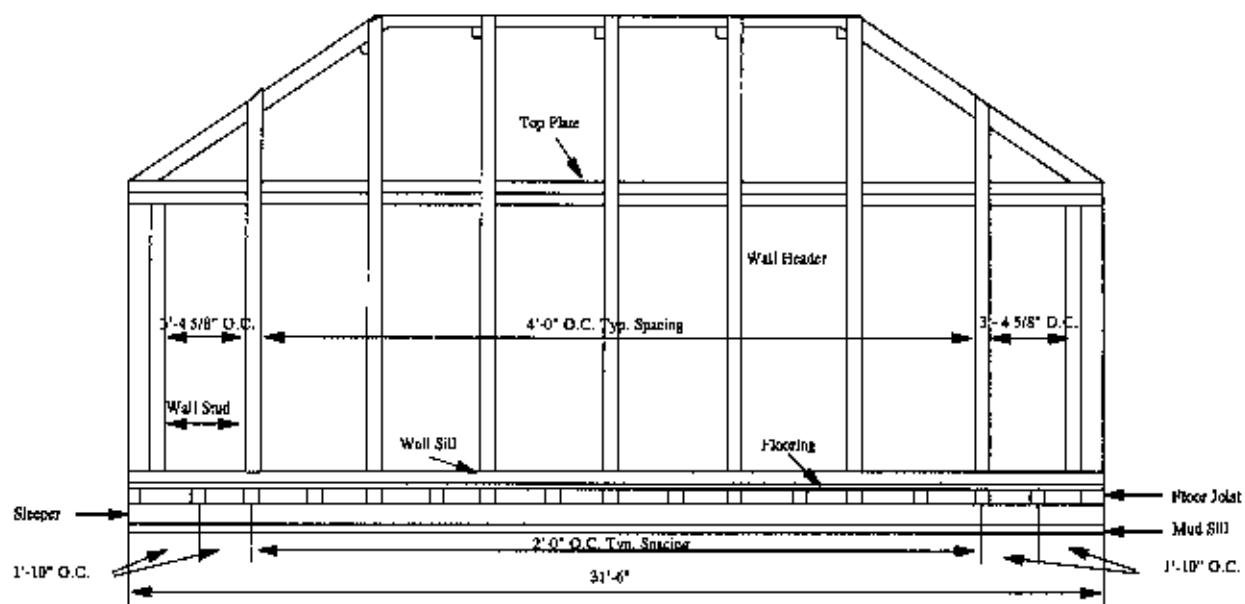
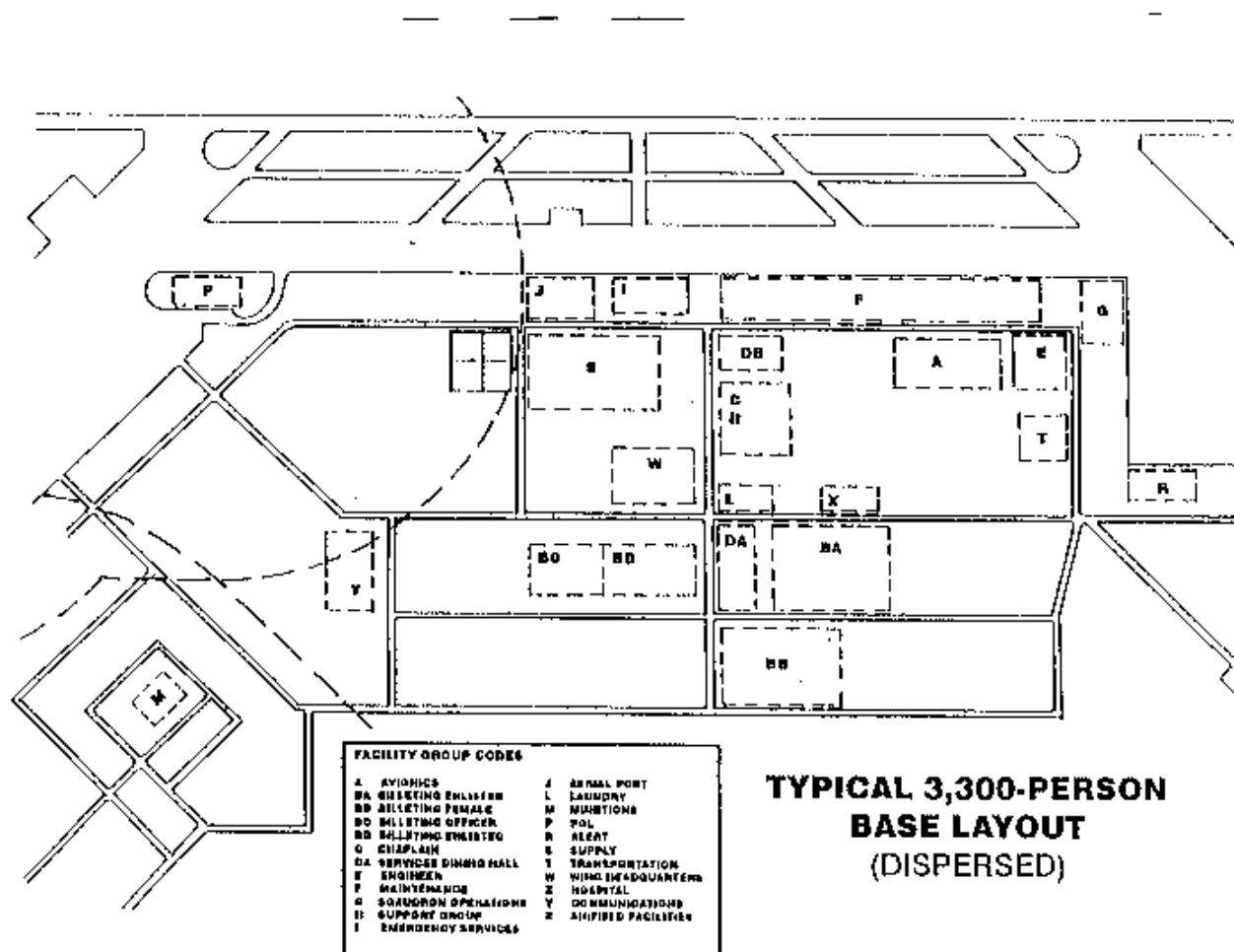


Figure A14.4. Side View.



DISPERSED FACILITY LAYOUTS

Figure A15.1. Typical 3,300-person Base Layout (Dispersed).



The following dispersed facility layouts (figures A15.2 through A15.21) using Harvest Falcon assets depict just one of the many possible combinations of facility groupings representing bare base functional areas. It is entirely possible that the groupings will be altered somewhat at your location due to functional area population variances, differing mission requirements, varying arrival times of facility assets, or local redistribution of facility assets.

Figure A15.2. Facility Group A Avionics.

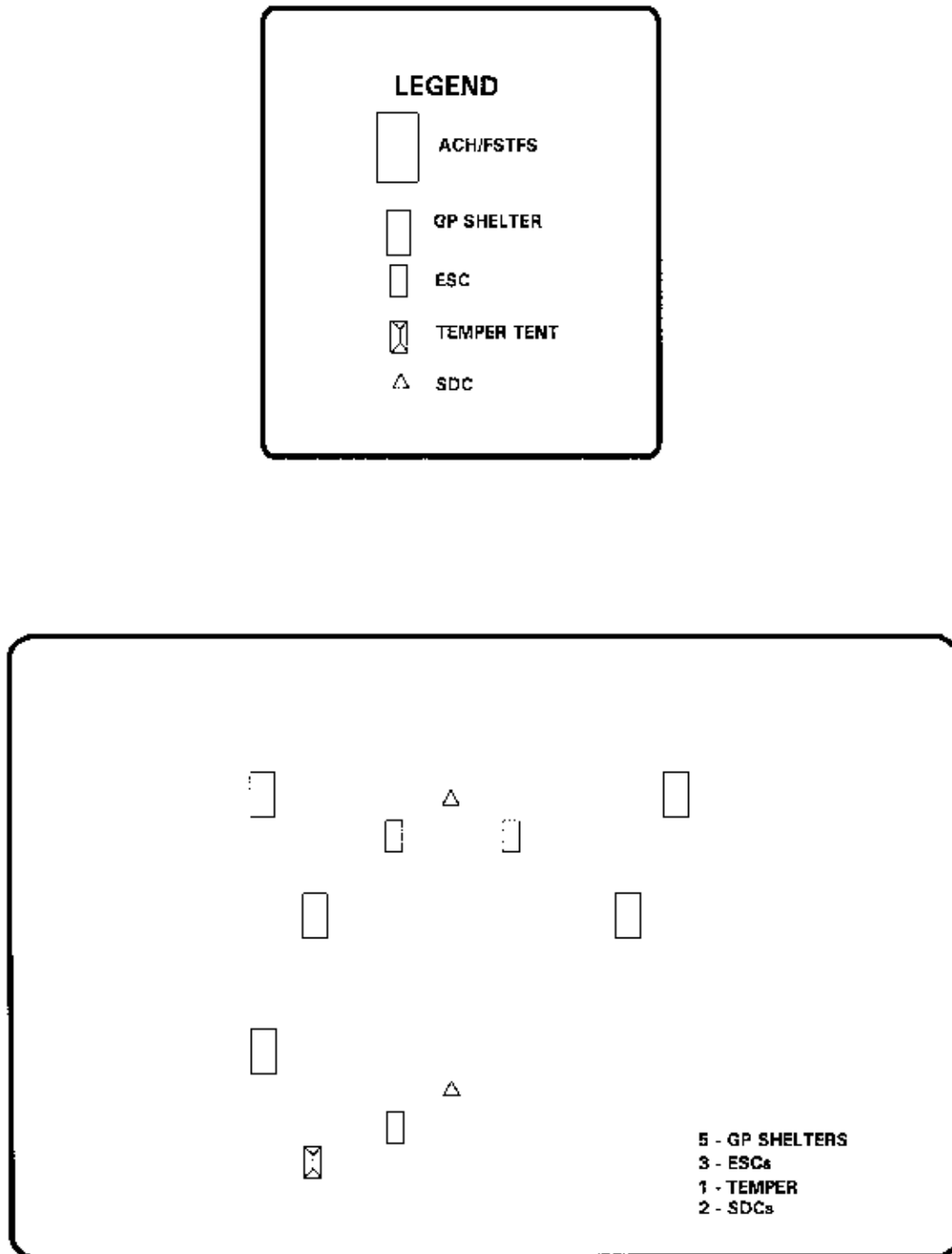


Figure A15.3. Facility Group BA Billeting.

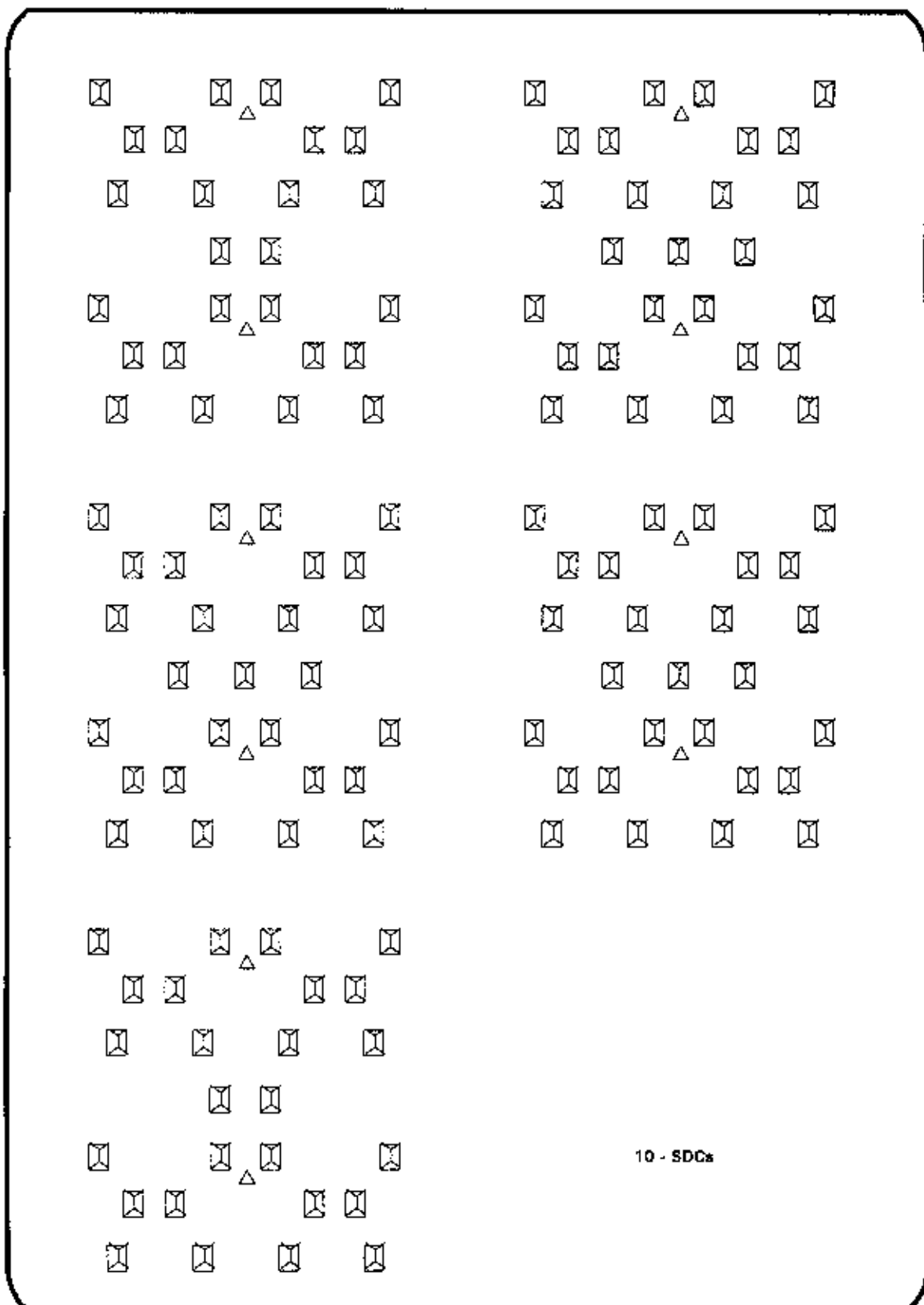


Figure A15.4. Facility Group BB Billeting.

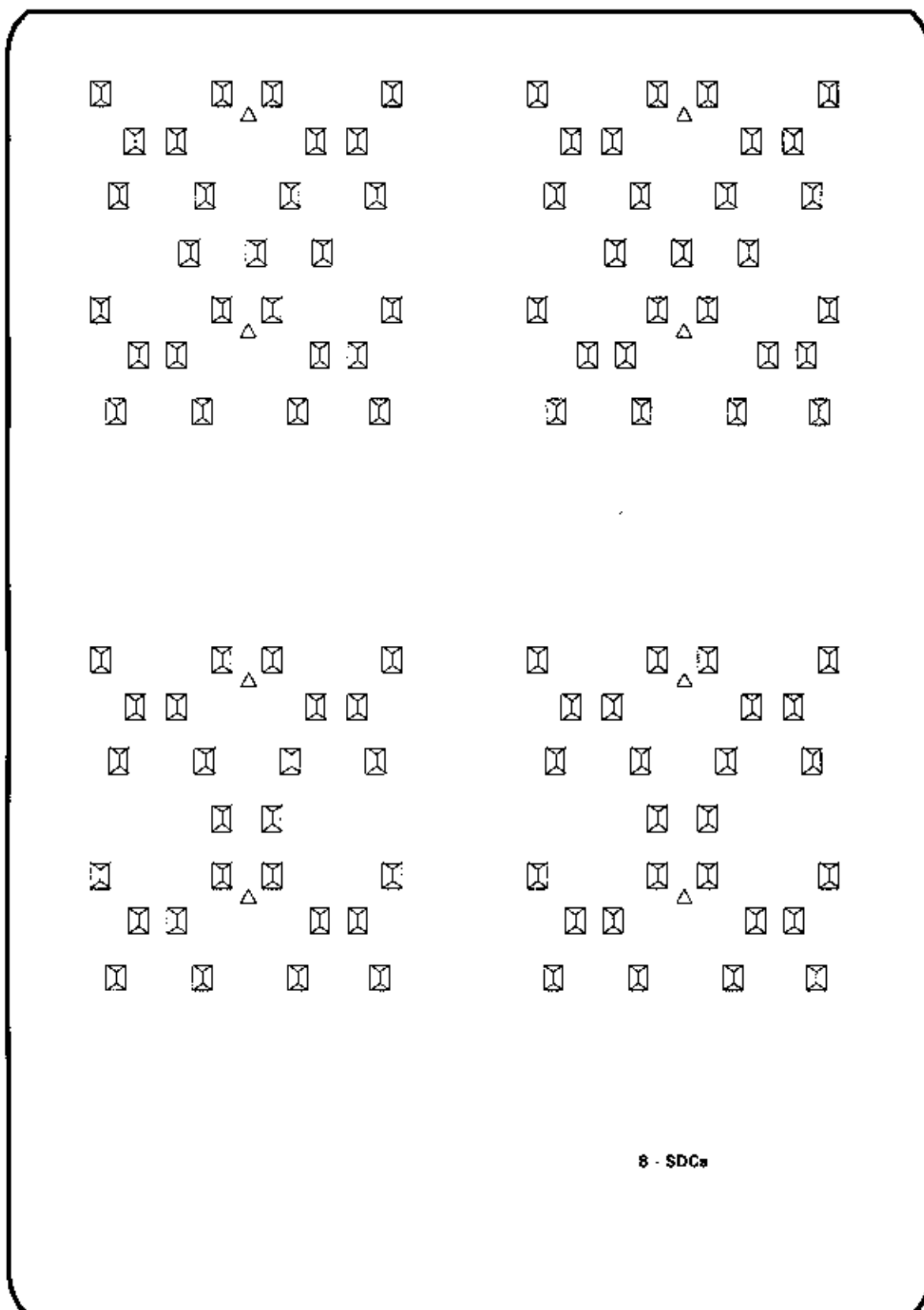


Figure A15.5. Facility Group BC Billeting.

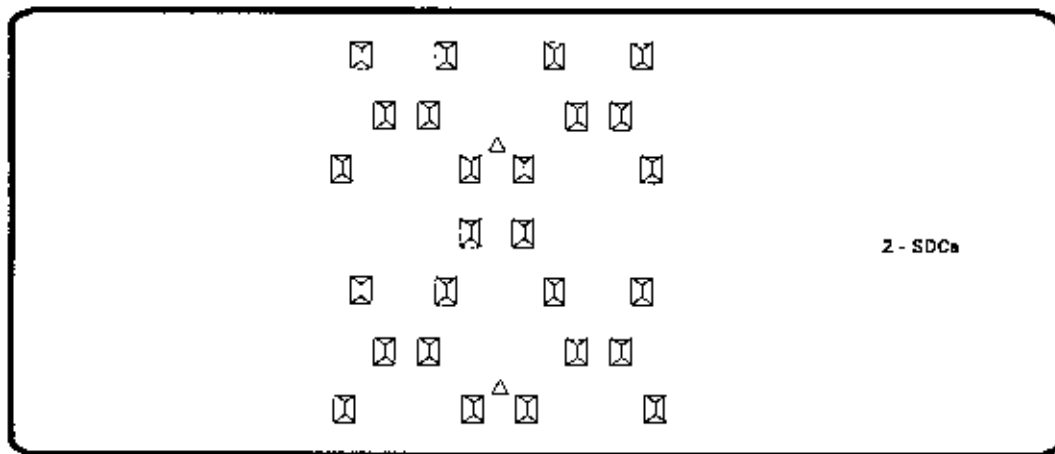


Figure A15.6. Facility Group BD Billeting.

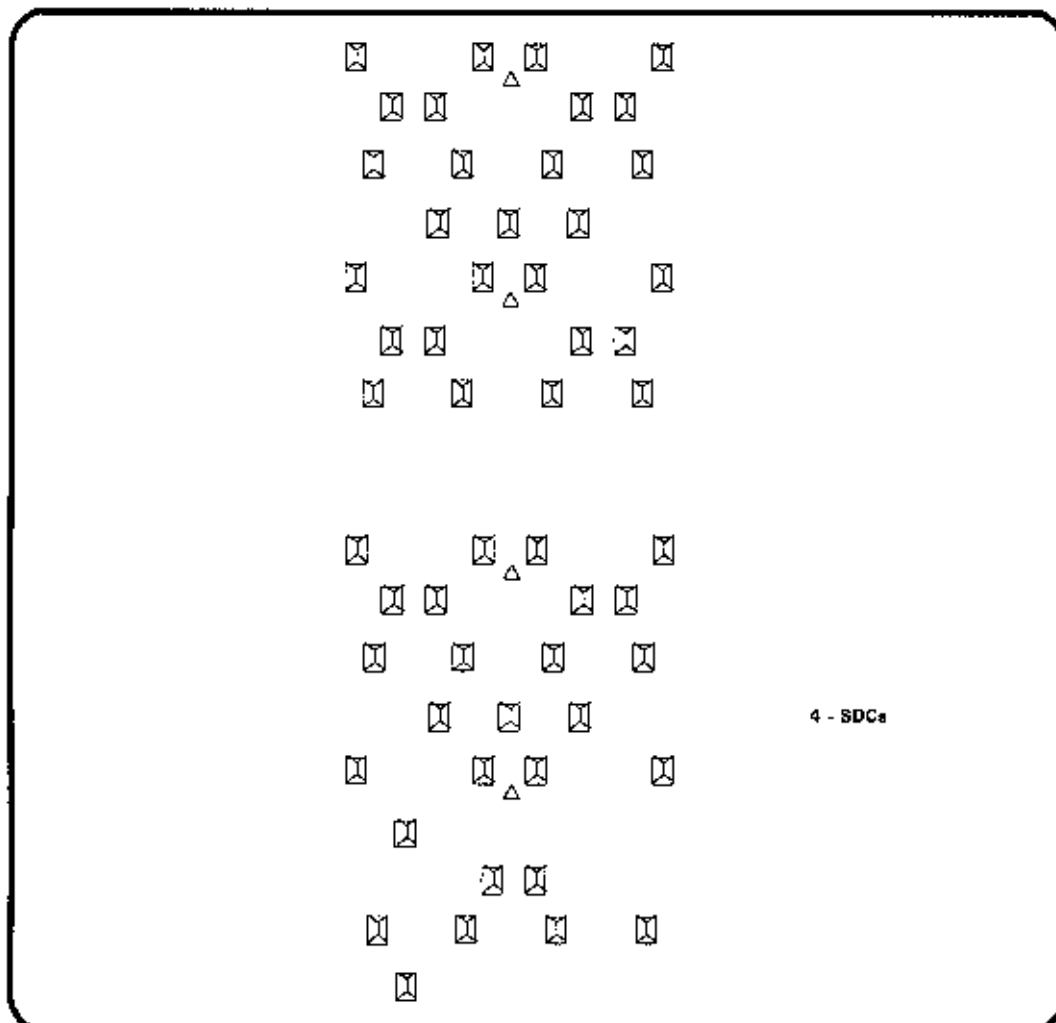


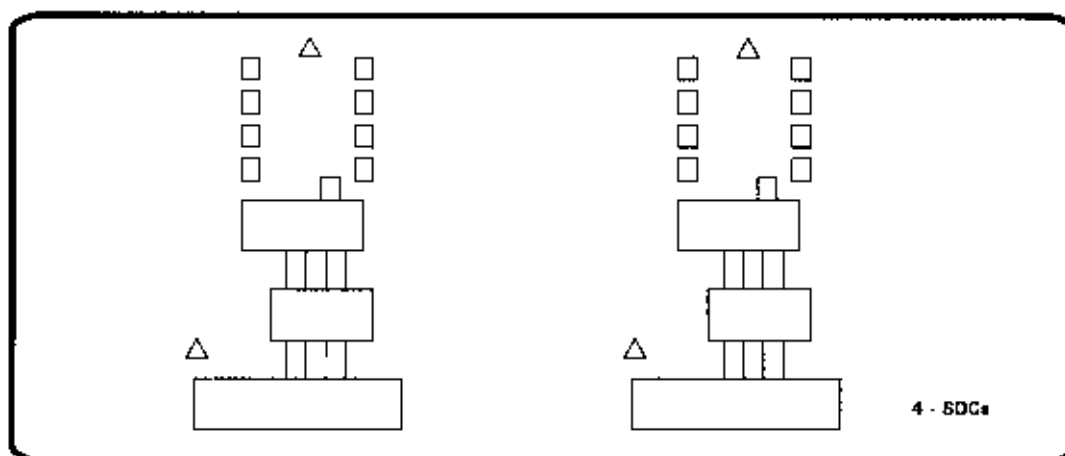
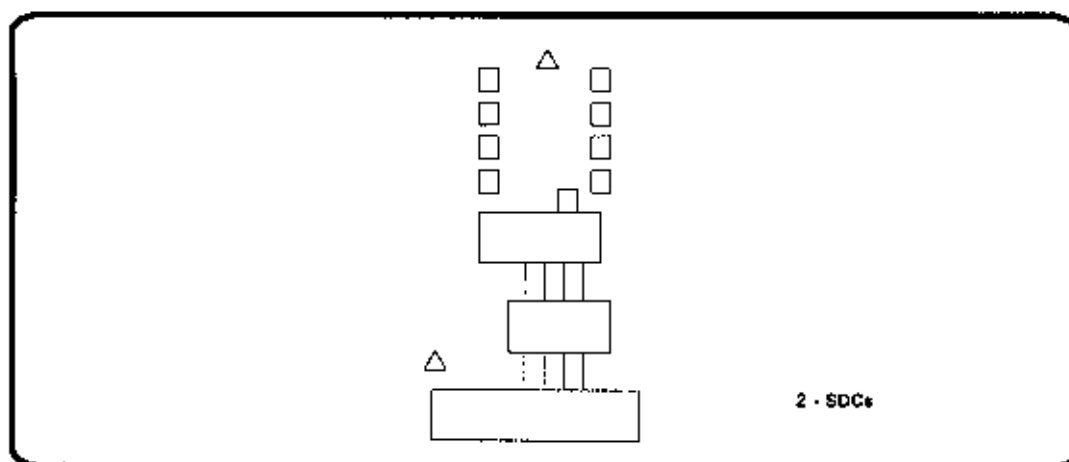
Figure A15.7. Facility Group DA Dining Facilities Billeting Area.**Figure A15.8. Facility Group DB Dining Facilities Flightline Area.**

Figure A15.9. Facility Group E Civil Engineer.

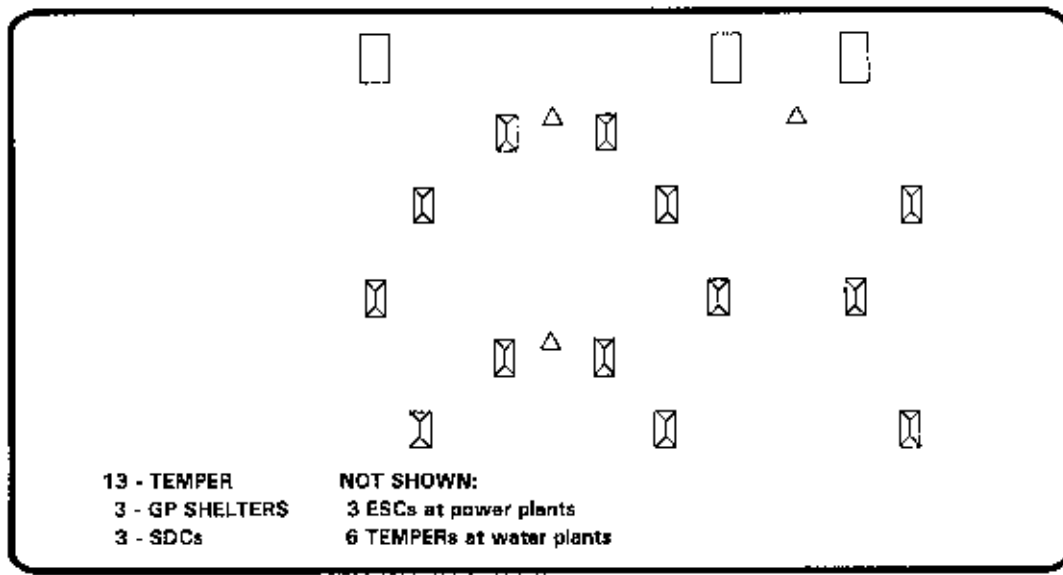


Figure A15.10. Facility Group F Maintenance.

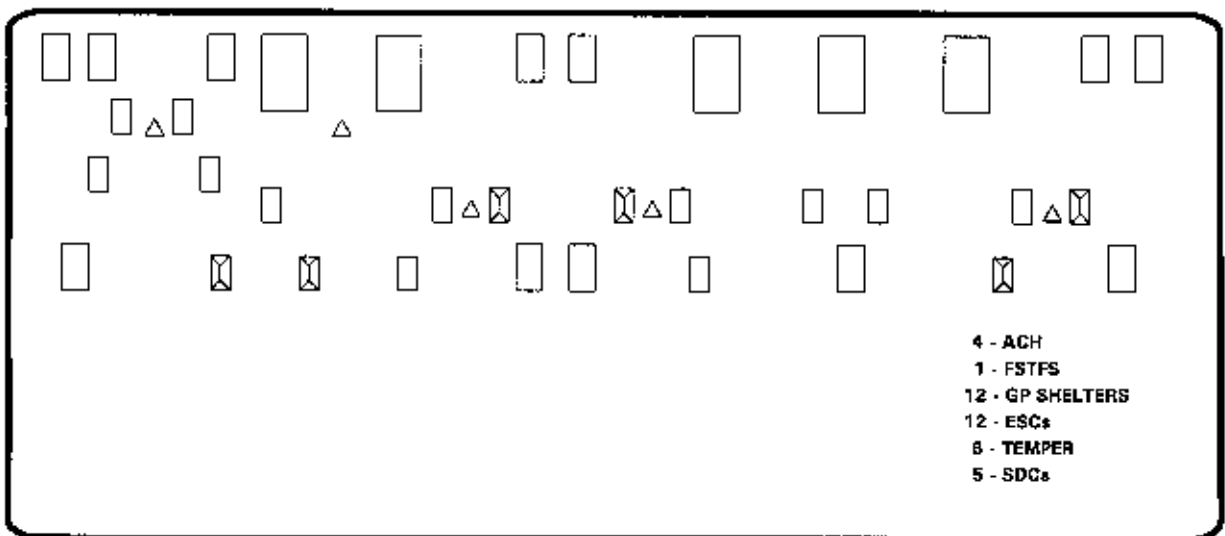


Figure A15.11. Facility Group G Flying Squadron Operations.

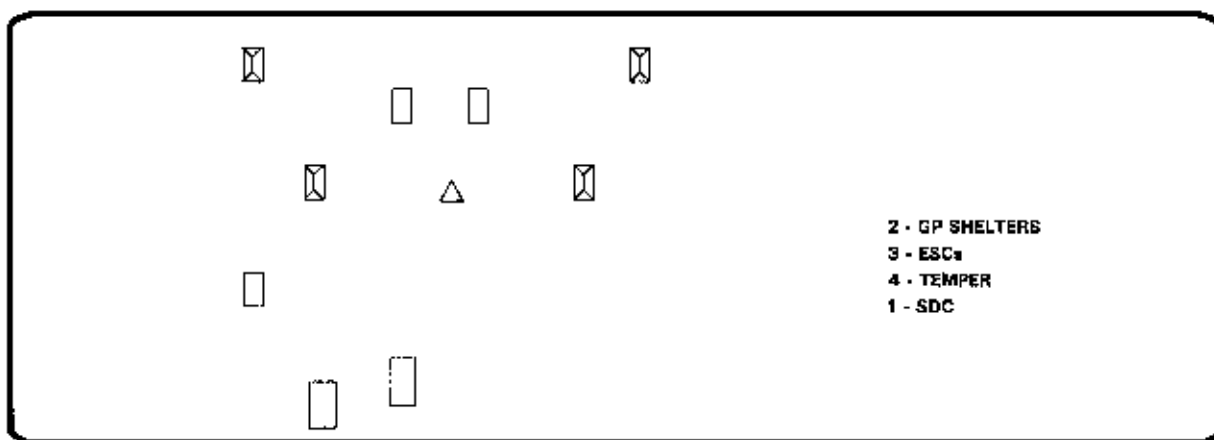


Figure A15.12. Facility Groups C and H Chaplain and Support.

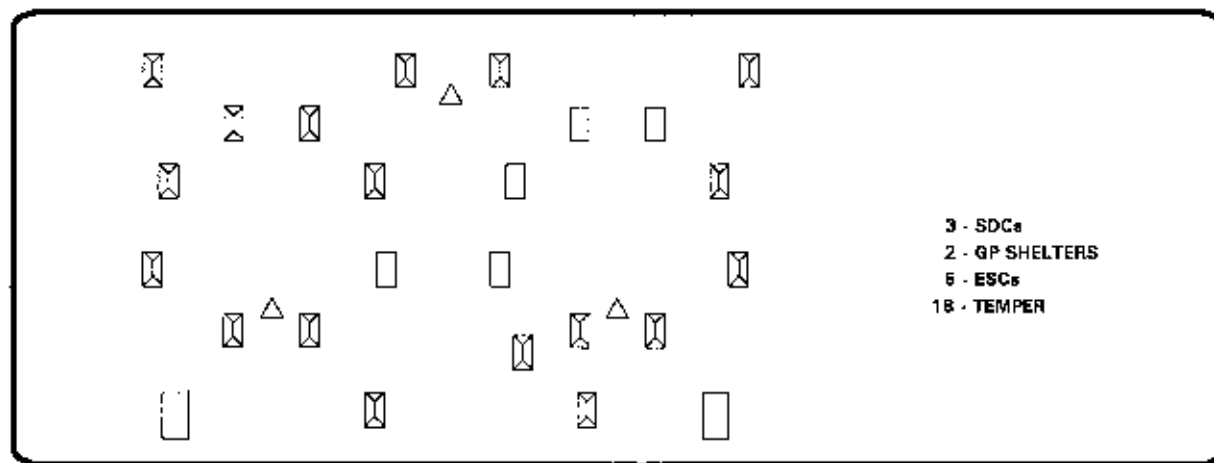


Figure A15.13. Facility Group I

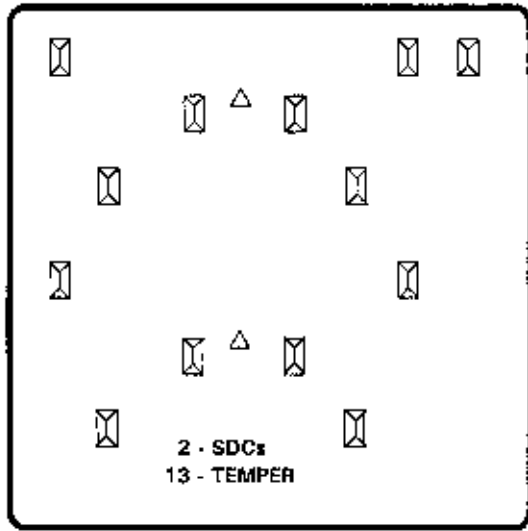


Figure A15.14. Facility Group J
Emergency Services. Aerial Port.

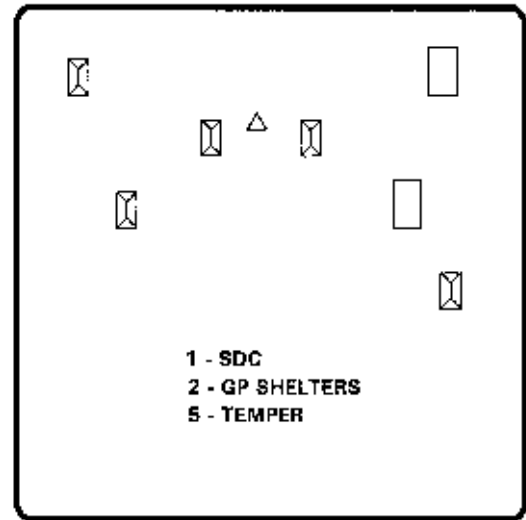


Figure A15.15. Facility Group L

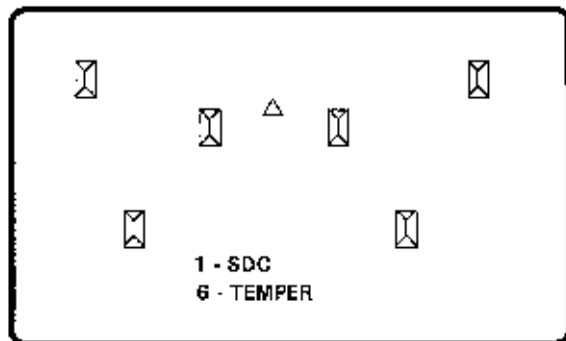


Figure A15.16. Facility Group M
Laundry. Munitions.

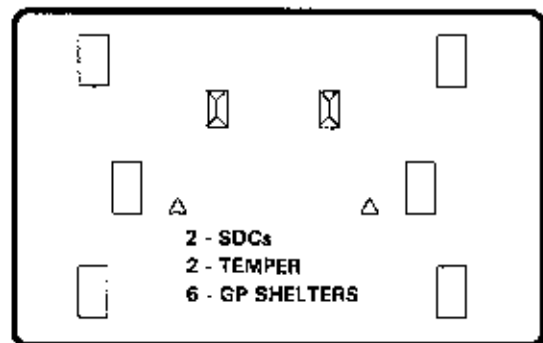


Figure A15.17. Facility Group

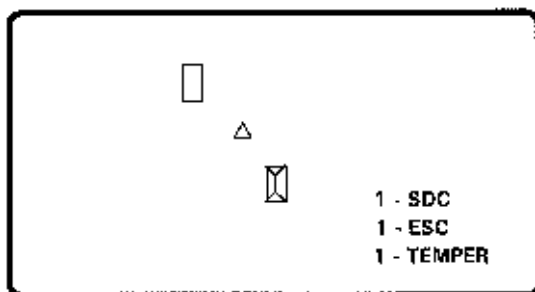


Figure A15.18. Facility Group
P POL. R ALERT.

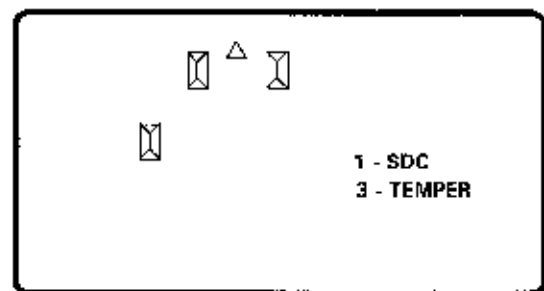


Figure A15.19. Facility Group G Supply.

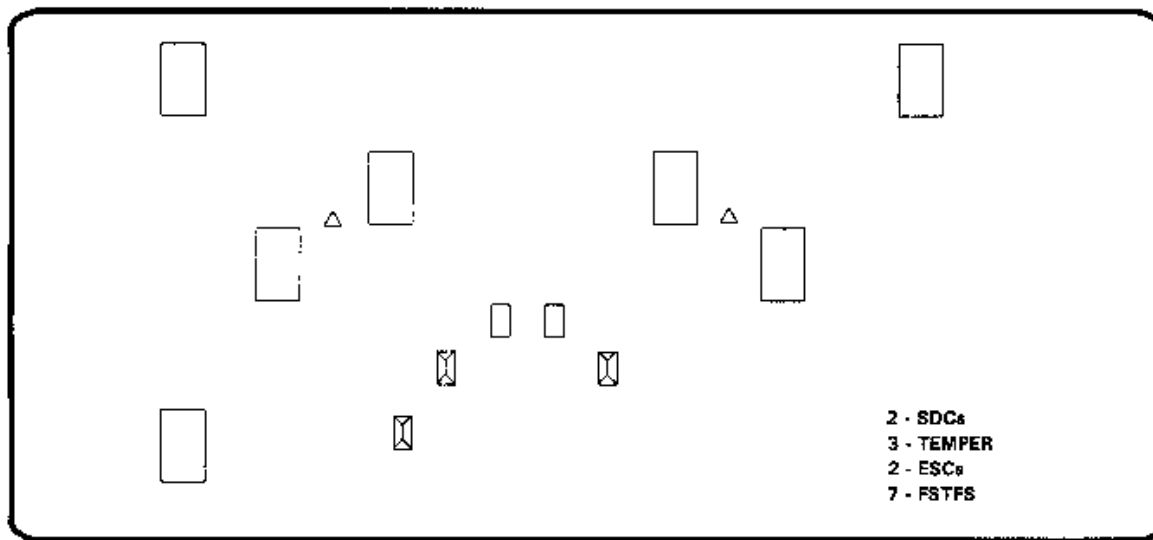


Figure A15.20. Facility Group T Transportation.

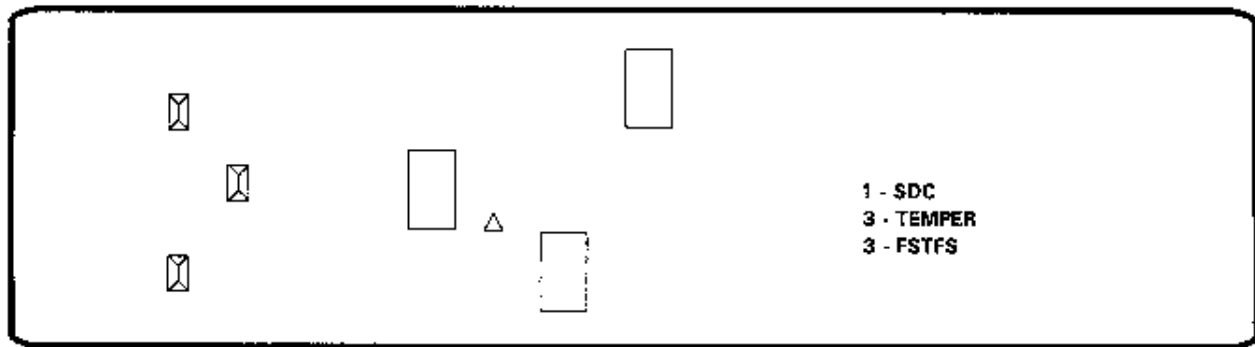
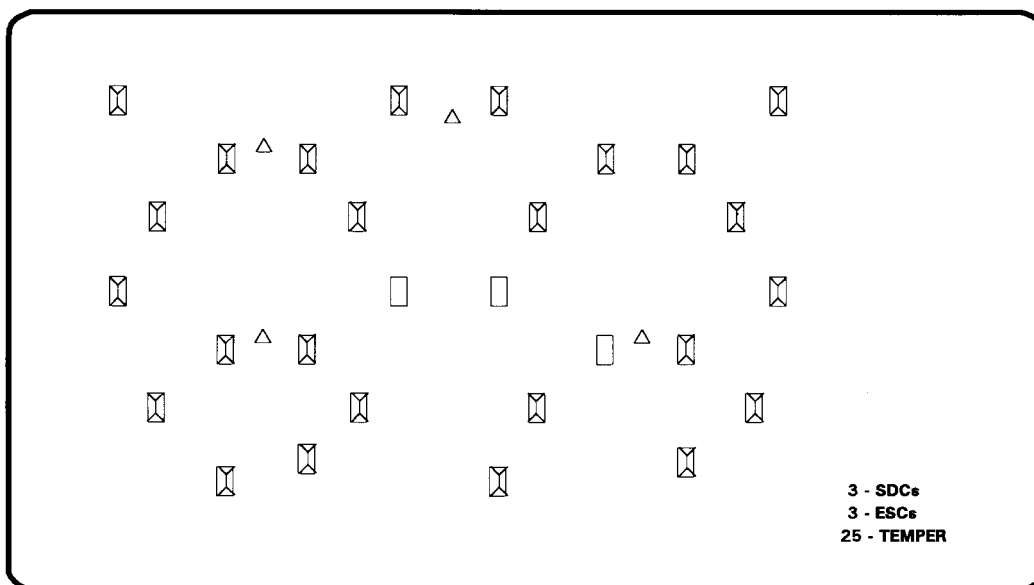


Figure A15.21. Facility Group W Wing Headquarters.



EXISTING FACILITIES AND RESOURCES CHECKLIST

1. COUNTRY:
2. NAME OF AIRFIELD:
3. ALTERNATE NAMES:
4. DATE OF INFORMATION:
5. DESCRIPTION OF REFERENCE POINT (RP)
 - A. LATITUDE (RP):
 - B. LONGITUDE (RP):
 - C. LOCATION OF THIS REFERENCE POINT (RP):
6. ELEVATION OF RP:
DESCRIPTIVE LOCATION (NAME & DISTANCE TO CLOSEST TOWN):

7. BASE POPULATION:
 - A. MILITARY:
 - B. CIVILIAN:
8. NEAREST US MILITARY INSTALLATION:
9. RUNWAYS/TAXIWAYS/AIRCRAFT SUPPORT STRUCTURE
 - A. ORIENTATION (Bearing to nearest degree; indicate MAG or TRUE)
RUNWAY #1 ____/____ RUNWAY #2 ____/
(North/South/East/West End) (North/South/East/West End)
 - B. ELEVATION OF RUNWAY ENDS; RUNWAY GRADIENT
RUNWAY #1 ____/____ RUNWAY #2 ____/____
 - C. LENGTH/WIDTH (Exact dimensions in feet or meters)
RUNWAY #1 ____/____ RUNWAY #2 ____/____

D. CONSTRUCTION (Type and thickness of surface; composition and depth of base; type sub-base; condition of runway.)

RUNWAY #1 _____

RUNWAY #2

E. CAPACITY (Gross weight for aircraft single wheel, twin wheel, and twin tandem type landing gear; maximum psi runway will support. Give Load Classification Number (LCN) Pavement Classification Number (PCN), if known).

RUNWAY #1 _____

RUNWAY #2

F. ARRESTING SYSTEM(S) (Type of system as barrier; cable or barrier/cable; identify system; capability; location identified by runway number and distance from runway end.)

RUNWAY #1 (Approach End)

RUNWAY #2 (Approach End)

RUNWAY #1 (Departure End)

RUNWAY #2 (Departure End)

G. RUNWAY OVERRUNS (Length, width, type, thickness and weight bearing capacity; composition and thickness of base; type sub-base, and LCN, if known. Give extensibility of runways and indicate sterilized portions.)

RUNWAY #1 (Approach End)

RUNWAY #2 (Approach End)

RUNWAY #1 (Departure End)

RUNWAY #2 (Departure End)

- H. RUNWAY REMARKS (Give surface, width and condition of shoulders. Describe runway numerals and other runway/taxiway markings. Give usability during wet seasons, if applicable; drainage, natural or artificial; take off and landing restrictions. Give type aircraft, at heaviest weight, if known, that have used the airfield and that could still be accommodated. Give description, location and height of obstructions along runways.)

RUNWAY #1 _____	RUNWAY #2 _____
_____	_____
_____	_____
_____	_____
_____	_____

- I. TAXIWAYS (Number, type, width, markings and the same construction and static load data as for the runway; location from RP; stabilized shoulder surface, width and condition; give lateral clearances or restrictions to include description, location and height of obstructions along taxiways.)

(1)	TAXIWAY (Name: _____) Width (main surface: _____) Asphalt, Concrete or other: Load Bearing Capability/Capacity (LCN or PCN): Obstructions: Markings:	Ref Point: Width (shoulder):
(2)	TAXIWAY (Name: _____) Width (main surface: _____) Asphalt, Concrete or other: Load Bearing Capability/Capacity (LCN or PCN): Obstructions: Markings:	Ref Point: Width (shoulder):
(3)	TAXIWAY (Name: _____) Width (main surface: _____) Asphalt, Concrete or other: Load Bearing Capability/Capacity (LCN or PCN): Obstructions: Markings:	Ref Point: Width (shoulder):
(4)	TAXIWAY (Name: _____) Width (main surface: _____) Asphalt, Concrete or other: Load Bearing Capability/Capacity (LCN or PCN): Obstructions: Markings:	Ref Point: Width (shoulder):

- (5) TAXIWAY (Name: _____) Ref Point:
 Width (main surface: _____) Width (shoulder):
 Asphalt, Concrete or other:
 Load Bearing Capability/Capacity (LCN or PCN):
 Obstructions:
 Markings:
- (6) TAXIWAY (Name: _____) Ref Point:
 Width (main surface: _____) Width (shoulder):
 Asphalt, Concrete or other:
 Load Bearing Capability/Capacity (LCN or PCN):
 Obstructions:
 Markings:
- (7) TAXIWAY (Name: _____) Ref Point:
 Width (main surface: _____) Width (shoulder):
 Asphalt, Concrete or other:
 Load Bearing Capability/Capacity (LCN or PCN):
 Obstructions:
 Markings:
- (8) TAXIWAY (Name: _____) Ref Point:
 Width (main surface: _____) Width (shoulder):
 Asphalt, Concrete or other:
 Load Bearing Capability/Capacity (LCN or PCN):
 Obstructions:
 Markings:
- (9) TAXIWAY (Name: _____) Ref Point:
 Width (main surface: _____) Width (shoulder):
 Asphalt, Concrete or other:
 Load Bearing Capability/Capacity (LCN or PCN):
 Obstructions:
 Markings:
- (10) TAXIWAY (Name: _____) Ref Point:
 Width (main surface: _____) Width (shoulder):
 Asphalt, Concrete or other:
 Load Bearing Capability/Capacity (LCN or PCN):
 Obstructions:
 Markings:
- J. APRONS, HARDSTANDS, REVETMENTS, OTHER PARKING (Location, number, type, dimensions, surface, condition, weight bearing capacity, accessibility and clearance limitations. For revetments, give embankment height, structure, size of entrance, is revetment covered.)
- (1) APRON (Name: _____) Ref Point:
 Dimensions: Width: _____ Length:
 Shoulder:
 Asphalt, Concrete or other:
 Load Bearing Capability/Capacity (LCN or PCN):
 Obstructions:
 Grounding Points:
 Lighting:
 Other Data:
-
- Revetments:
-
- (2) APRON (Name: _____) Ref Point:
 Dimensions: Width: _____ Length:
 Shoulder:
 Asphalt, Concrete or other:

Load Bearing Capability/Capacity (LCN or PCN):
 Obstructions:
 Grounding Points:
 Lighting:
 Other Data:

Revetments:

-
- (3) APRON (Name: _____) Ref Point:
 Dimensions: Width: _____ Length:
 Shoulder:
 Asphalt, Concrete or other:
 Load Bearing Capability/Capacity (LCN or PCN):
 Obstructions:
 Grounding Points:
 Lighting:
 Other Data:

Revetments:

-
- (4) APRON (Name: _____) Ref Point:
 Dimensions: Width: _____ Length:
 Shoulder:
 Asphalt, Concrete or other:
 Load Bearing Capability/Capacity (LCN or PCN):
 Obstructions:
 Grounding Points:
 Lighting:
 Other Data:

Revetments:

-
- (5) APRON (Name: _____) Ref Point:
 Dimensions: Width: _____ Length:
 Shoulder:
 Asphalt, Concrete or other:
 Load Bearing Capability/Capacity (LCN or PCN):
 Obstructions:
 Grounding Points:
 Lighting:
 Other Data:

Revetments:

-
- (6) APRON (Name: _____) Ref Point:
 Dimensions: Width: _____ Length:
 Shoulder:
 Asphalt, Concrete or other:
 Load Bearing Capability/Capacity (LCN or PCN):
 Obstructions:
 Grounding Points:
 Lighting:
 Other Data:

Revetments:

K. AIRCRAFT SHELTERS (list size, type, interior dimensions, door size):

L. APPROACH OBSTRUCTIONS (On aerodrome or near vicinity; give location, description, height above ground and sea level, lighted or unlighted, i.e., towers, buildings, hills. Describe approach terrain, especially on final approach.)

M. NAVIGATIONAL AND LANDING AIDS

(1) NAVIGATIONAL AIDS (Types, hours of operation, English spoken, location.)

(2) OTHER DATA: Submit layout plan; visual and instrument approach diagram; and graphics:

10. LIGHTING

A. RUNWAY (High or low intensity, include which runways, the dimming capability, and if flush mounted or elevated; centerline; runway flood; runway strip; portable electric, goose necks; emergency; auxiliary power for lighting; and times of operation or are lights on request. If available, list back-up power.)

B. APPROACH (Indicate type runway serviced, U.S. standard, neon ladder, left row, etc.; state intensity; list touchdown zone lighting, approach light beacon, sequence flashing, VASI, REIL and VAPI.)

C. OTHER (Types including taxiway, beacons, apron flood, threshold, obstruction, boundary, lighted wind indicator, hangar area, flares-all variations and details pertaining to lighting systems should be covered.)

11. OTHER DATA ON AIRFIELD

A. VISUAL IDENTIFICATION (Location of markers, wind indicators, control tower and rotating beacon.)

B. OPERATING AND USING AGENCIES (Occupying military units, commercial air carriers and organizational units having airfield maintenance responsibility. List separately those activities which are categorized only as users. Give number and type of aircraft that have or are presently using this facility.)

C. CURRENT AND FUTURE CONSTRUCTION (provide detailed information on proposed expansion plans and improvements program in progress; give status and proposed completion date(s).)

MAINTENANCE AND ACCESSORIES

12. HANGARS

A. HANGAR (number/name):

DIMENSIONS IN FEET

(1) Floor space:

(2) Doors (Height and Width):

ENVIRONMENTALLY CONTROLLED (Yes or No)

MATERIAL AND TYPE OF CONSTRUCTION (Double bay, open end, steel,
concrete, wood, sheet metal)

LOCATION FROM REFERENCE POINT OR NEAREST RAMP:

B. HANGAR (number/name):

DIMENSIONS IN FEET

(1) Floor space:

(2) Doors (Height and Width):

ENVIRONMENTALLY CONTROLLED (Yes or No)

MATERIAL AND TYPE OF CONSTRUCTION (Double bay, open end, steel,
concrete, wood, sheet metal)

LOCATION FROM REFERENCE POINT OR NEAREST RAMP:_____

C. HANGAR (number/name):

DIMENSIONS IN FEET

(1) Floor space:

(2) Doors (Height and Width):

ENVIRONMENTALLY CONTROLLED (Yes or No)

MATERIAL AND TYPE OF CONSTRUCTION (Double bay, open end, steel,
concrete, wood, sheet metal)

LOCATION FROM REFERENCE POINT OR NEAREST RAMP:

13. GROUND SUPPORT EQUIPMENT (Give model, capacity and quantity of portable line equipment such as AC/DC generators, auxiliary power units, aircraft heaters, aircraft air conditioners, air compressors, hydraulic test stands, light carts and other powered aerospace ground equipment (AGE).)
-
-
-
-
14. ENGINE TESTING (describe engine or aircraft tie-down points, test stand and blast fences, also note thrust load capabilities):
-
-
-
-
15. HAZARDOUS CARGO PAD (describe size and location):
16. HOT BRAKE PAD (describe where aircraft with hot brakes rest while waiting for the brakes to cool)
-
-
17. ORDNANCE STORAGE (Type munitions, type storage, i.e., bunker, underground, above ground, open field, etc. Indicate quantity of storage facilities, number and dimensions of buildings, security.)

- | | | |
|-------|--|-----------------------------------|
| A. | BUNKER (Name: _____)
Dimensions: Width: _____
Height: _____
Earth Bank, Concrete or Other: _____
Capacity: _____
Distance to Loading Pad: _____
Lighting: _____
Other Data: _____ | Ref Point: _____
Length: _____ |
| <hr/> | | |
| B. | BUNKER (Name: _____)
Dimensions: Width: _____
Height: _____
Earth Bank, Concrete or Other: _____
Capacity: _____
Distance to Loading Pad: _____
Lighting: _____
Other Data: _____ | Ref Point: _____
Length: _____ |
| <hr/> | | |
| C. | BUNKER (Name: _____)
Dimensions: Width: _____
Height: _____
Earth Bank, Concrete or Other: _____
Capacity: _____
Distance to Loading Pad: _____
Lighting: _____
Other Data: _____ | Ref Point: _____
Length: _____ |
| <hr/> | | |
| D. | BUNKER (Name: _____)
Dimensions: Width: _____
Height: _____
Earth Bank, Concrete or Other: _____
Capacity: _____
Distance to Loading Pad: _____
Lighting: _____
Other Data: _____ | Ref Point: _____
Length: _____ |
| <hr/> | | |
| E. | BUNKER (Name: _____)
Dimensions: Width: _____
Height: _____
Earth Bank, Concrete or Other: _____
Capacity: _____
Distance to Loading Pad: _____
Lighting: _____
Other Data: _____ | Ref Point: _____
Length: _____ |
| <hr/> | | |

PETROLEUMS, OILS, AND LUBRICANTS (POL)

18. FUEL:

- A. ON BASE (Give types and grades of military and commercial aviation fuels, normal stock level for each grade fuel listed. For commercial facilities indicate by whom owned and operated; what fuel additives are used. By product, list type of storage, i.e., steel tanks, above ground, underground, drum, etc. Indicate location, capacity each and/or total storage capacity).

-
-
- B. OFF BASE STORAGE (data as above, if available from airport authorities. Also describe how this fuel gets to the airfield.)

-
-
-
- C. FUEL DISPENSING METHOD (List refueling units by products, number, type. Describe hydrant and pumping system, location from RP, number, rated capacity of each hydrant (GPM), and pits, number and type hose carts or trucks, number and type nozzles. Give number of fill stands and rate (GPM) for each grade of fuel, indicate by whom owned and operated.)

19. OIL AND LUBRICANTS:

- A. ON BASE (Stocks and grades maintained for reciprocating jet and turbine, list types of containers by product, capacity, stock level, and resupply method).

B. OFF BASE STORAGE (data as above, if available from airport authorities.)

C. TRANSPORT (describe method of movement):

20. SPECIAL PURPOSE EQUIPMENT

A. AIRCRAFT SUPPORT (tugs, ladder trucks, etc.):

B. CRASH AND FIRE EQUIPMENT (Number, type and class of units, condition, location on field or nearby, hours of availability. State in gallons the capacity of fire trucks. Indicate the availability of water hydrants, special water tanks, portable extinguisher and extinguishing agents, and fire suppression helicopters.)

(1) Water Dispensing Aircraft:

(2) P-4/P-19:

(3) P-10:

(4) P-18:

(5) Other Water Tankers:

(6) P-20:

(7) Foreign Vehicles:

(8) Other USAF Vehicles:

(9) Command & Control Vehicle(s):

(10) 150 Pound Flightline Fire Bottles:

(11) K-12 Saws:

(12) Jaws of Life:

(13) Scott Air Packs:

(14) Ability to fill air tanks (Scott Air Packs)

(15) Types and availability of agents:

C. WRECKAGE REMOVAL EQUIPMENT (Number, type, i.e., wreckers, hoists, cranes, crash dollies and other equipment, condition.)

D. OTHER SPECIAL PURPOSE VEHICLES (i.e., sand removal, tractors, runway cleaners, graders, etc., condition.)

(1) Backhoes:

- (2) Dozers: _____
- (3) Dump Trucks: _____
- (4) Excavators: _____
- (5) Farm Tractors: _____
- (6) Flatbeds: _____
- (7) Forklifts: _____
- (8) Graders: _____
- (9) Kick Broom Sweepers: _____
- (10) Loaders: _____
- (11) Paint Machines: _____
- (12) Rollers: _____
- (13) Sewage Servicing/Fleet Servicing: _____
- (14) Trailer Tractors: _____
- (15) Trenchers: _____
- (16) Vacuum Sweepers: _____
- (17) Water Trucks/Tankers: _____
- (18) Snow Removal Equipment: _____

E. NBC DETECTION, WARNING AND REPORTING SYSTEMS (availability and types of equipment, condition, how activated):

21. BASE SERVICES/BASE INFRASTRUCTURE

A. PERSONNEL ACCOMMODATIONS (Give number of permanent or temporary buildings, dimensions and conditions. Give normal and maximum capacity for officers and airmen. State percentage of space utilization on base only.)

B. LATRINES (number and location for both the living and working areas):

- C. SHOWERS (number, condition and proximity to living area): _____

- D. MESSING FACILITIES (Give normal and maximum messing capacity for officers and airmen. Availability of mess hall, dining rooms, field kitchens, etc., condition and accessibility.)

- E. LAUNDRY SERVICES _____

- F. MORTUARY SERVICES _____

- G. STORAGE (Give number, dimensions and conditions of warehouses, sheds, etc. Location and size of open storage areas, refrigerated storage. Indicate percentage in use.)

- H. MEDICAL/DENTAL (Indicate name, type and location of all medical facilities available, normal bed capacity for each hospital. Indicate all medical staffing, i.e., doctors, dentists, nurses, etc. Indicate number of ambulances available.)

- I. WATER SUPPLY (Source of water, i.e., well, water shed, brought in by can, tank car. Quantity, normal and maximum gallons per 24 hours storage capacity, i.e., storage tank, reservoirs, potability. Indicate the location and amount of emergency water supply. Also indicate if water is treated (chlorine, fluoride, etc.) and if the water has been tested, list test results):

- J. AVAILABLE BUILDINGS (Consider location, type, total floor space, number of personnel currently working within, expansion in contingency or emergency situations.)

(1) Building Number or Name:

Floor Space:

Description of current use:

Lighting (Yes/No)		Electrical Outlets (Yes/No)
Voltage: _____	Cycles/Hertz:	
Latrines (type and quantity):		
Drinking Water Available:		
Environmentally Controlled (Yes/No)		

(2) Building Number or Name:

Floor Space:

Description of current use:

Lighting (Yes/No)		Electrical Outlets (Yes/No)
Voltage: _____	Cycles/Hertz:	
Latrines (type and quantity):		
Drinking Water Available:		
Environmentally Controlled (Yes/No)		

(3) Building Number or Name:

Floor Space:

Description of current use:

Lighting (Yes/No)		Electrical Outlets (Yes/No)
Voltage: _____	Cycles/Hertz:	
Latrines (type and quantity):		
Drinking Water Available:		
Environmentally Controlled (Yes/No)		

(4) Building Number or Name:

Floor Space:

Description of current use:

Lighting (Yes/No)		Electrical Outlets (Yes/No)
Voltage: _____	Cycles/Hertz:	
Latrines (type and quantity):		
Drinking Water Available:		
Environmentally Controlled (Yes/No)		

(5) Building Number or Name:

Floor Space:

Description of current use:

Lighting (Yes/No)		Electrical Outlets (Yes/No)
Voltage: _____	Cycles/Hertz:	
Latrines (type and quantity):		
Drinking Water Available:		
Environmentally Controlled (Yes/No)		

(6) Building Number or Name:

Floor Space:

Description of current use:

Lighting (Yes/No) _____ Electrical Outlets (Yes/No) _____
 Voltage: _____ Cycles/Hertz: _____
 Latrines (type and quantity): _____
 Drinking Water Available: _____
 Environmentally Controlled (Yes/No) _____

(7) Building Number or Name:

Floor Space:

Description of current use:

Lighting (Yes/No) _____ Electrical Outlets (Yes/No) _____
 Voltage: _____ Cycles/Hertz: _____
 Latrines (type and quantity): _____
 Drinking Water Available: _____
 Environmentally Controlled (Yes/No) _____

(8) Building Number or Name:

Floor Space:

Description of current use:

Lighting (Yes/No) _____ Electrical Outlets (Yes/No) _____
 Voltage: _____ Cycles/Hertz: _____
 Latrines (type and quantity): _____
 Drinking Water Available: _____
 Environmentally Controlled (Yes/No) _____

- K. ELECTRICAL POWER SOURCES (Note location, reliability, type, i.e., A/C, D/C; capacity in kilowatts or kilovolt ampere, cycles; single or three phase; voltage, i.e., 110/220, 220/440. Indicate type of emergency equipment, output and reliability.)

- L. SOLID WASTE DISPOSAL (Method, Source, Capacity, Frequency):

- M. SEWAGE (On-Base capability, capacity, type of treatment; commercial capability, capacity, type of treatment):

- N. INSECT/RODENT CONTROL (Source, capability):

- O. AIR PASSENGER TERMINAL (Give specific terminal information to include dimensions, internal layout, maximum capacity, installed baggage handling system, location and security.)

- P. RAILROAD AND HIGHWAYS (Number of sidings and/or spurs on base and what facilities serviced) (Access roads supporting airfield; type surface, width, condition, capacity of highway and bridges.)

- Q. TELEPHONES (Manual, automatic; number of switchboard lines, number of terminal points of direct line circuits. Hot line available?)

- R. RADIOS (types, frequencies, etc.): _____

- S. OTHER COMMUNICATIONS (area broadcasting systems/loudspeakers, local radio or television systems and location): _____

22. SUPPLIES AND/OR ADDITIONAL EQUIPMENT

- A. ON SITE AVAILABLE SUPPLIES OR EQUIPMENT (Prepositioned, stored locally, or loaned by the hosts): _____

- B. OFF SITE AVAILABLE MATERIALS (list sources for electrical, plumbing, carpentry, construction supplies, etc., and their proximity to the site):

- C. SUPPLIES AND MATERIALS NEEDED (To be sent with the deploying unit and/or headquarters element): _____

- D. CONTRACT SUPPLIED OR SERVICES AVAILABLE: _____

E. LOCAL CONSTRUCTION COMPANIES: _____

CONVERSION FACTORS

MULTIPLY	BY	TO OBTAIN
Acres	43,560	square feet
Acres	4,047	square meters
Acres	1.562×10^{-3}	square miles
Acres	5645.38	square varas
Acres	4,840	square yards
Acre-feet	43,560	cubic-feet
Atmospheres	76.0	cms. of mercury
Atmospheres	29.92	inches of mercury
Atmospheres	33.90	feet of water
Atmospheres	10,333	kgs. per square meter
Atmospheres	14.70	pounds per square inch
Atmospheres	1.058	tons per square foot
Bars	9.870×10^{-7}	atmospheres
Bars	1	dynes per square cm.
Bars	0.01020	kgs. per square meter
Bars	2.089×10^{-3}	pounds per square foot
Bars	1.450×10^{-5}	pounds per square inch
Board-feet	144 sq in x 1 in	cubic inches
British thermal units	0.2520	kilogram-calories
British thermal units	777.5	foot-pounds
British thermal units	3.927×10^{-4}	horsepower-hours
British thermal units	1.054	joules
British thermal units	107.5	kilogram-meters
British thermal units	2.928×10^{-4}	kilowatt-hours
BTU per minute	12.96	foot-pounds per second
BTU per minute	0.02356	horsepower
BTU per minute	0.01757	kilowatts
BTU per minute	17.57	watts
BTU per sq ft per min	0.1220	watts per square inch
Bushels	1.244	cubic feet
Bushels	2,150	cubic inches
Bushels	0.03524	cubic meters
Bushels	4	pecks
Bushels	64	pints (dry)
Bushels	32	quarts (dry)

MULTIPLY	BY	TO OBTAIN
Centares	1	square meters
Centigrams	0.01	grams
Centiliters	0.01	liters
Centimeters	0.3937	inches
Centimeters	0.01	meters
Centimeters	393.7	mils
Centimeters	10	millimeters
Centimeters-dynes	7.233×10^{-5}	centimeter-grams
Centimeter-dynes	1.020×10^{-8}	meter-kilograms
Centimeter-dynes	7.376×10^{-8}	pound-feet
Centimeter-grams	980.7	centimeter-dynes
Centimeter-grams	10^{-3}	meter-kilograms

Centimeters-grams	7.233×10^{-3}	pound-feet
Centimeters of mercury	0.01316	atmospheres
Centimeters of mercury	0.4461	feet of water
Centimeters of mercury	136.0	kgs. per square meter
Centimeters of mercury	27.85	pounds per square foot
Centimeters of mercury	0.1934	pounds per square inch
Centimeters per second	1.969	feet per minute
Centimeters per second	0.03281	feet per second
Centimeters per second	0.036	kilometers per hour
Centimeters per second	0.6	meters per minute
Centimeters per second	0.02237	miles per hour
Centimeters per second	3.728×10^{-4}	miles per minute
Cms per sec per sec	0.03281	feet per second per second
Cms per sec per sec	0.036	kms. per hour per second
Cms per sec per sec	0.02237	miles per hour per second
Circular mils	5.067×10^{-6}	square centimeters
Circular mils	7.854×10^{-7}	square inches
Circular mils	0.7854	square mils
Cord-feet	4 ft x 4 ft x 1 ft	cubic feet
Cords	8 ft x 4 ft x 4 ft	cubic feet
Cubic centimeters	3.531×10^{-5}	cubic feet
Cubic centimeters	6.102×10^{-2}	cubic inches
Cubic centimeters	10^{-6}	cubic meters
Cubic centimeters	1.308×10^{-6}	cubic yards
Cubic centimeters	2.642×10^{-4}	gallons
Cubic centimeters	10^{-3}	liters
Cubic centimeters	2.113×10^{-3}	pints (liquid)
Cubic centimeters	1.057×10^{-3}	quarts (liquid)
Cubic feet	2.832×10^4	cubic cms.
Cubic feet	1,728	cubic inches
MULTIPLY	BY	TO OBTAIN
Cubic feet	0.02832	cubic meters
Cubic feet	0.03704	cubic yards
Cubic feet	7.481	gallons
Cubic feet	28.38	liters
Cubic feet	59.84	pints (liquid)
Cubic feet	29.92	quarts (liquid)
Cubic feet per minute	472.0	cubic cms.
Cubic feet per minute	0.1247	gallons per second
Cubic feet per minute	0.7420	liters per second
Cubic feet per minute	62.4	pounds of water per minute
Cubic inches	16.39	cubic centimeters
Cubic inches	5.787×10^{-4}	cubic feet
Cubic inches	1.639×10^{-5}	cubic meters
Cubic inches	2.143×10^{-5}	cubic yards
Cubic inches	4.329×10^{-3}	gallons
Cubic inches	1.639×10^{-2}	liters
Cubic inches	0.03463	pints (liquid)
Cubic inches	0.01732	quarts (liquid)
Cubic meters	10^6	cubic centimeters
Cubic meters	35.31	cubic feet
Cubic meters	61,023	cubic inches
Cubic meters	1.308	cubic yards
Cubic meters	264.2	gallons
Cubic meters	10^3	liters

Cubic meters	2113	pints (liquid)
Cubic meters	1057	quarts (liquid)
Cubic yards	7.646×10^5	cubic centimeters
Cubic yards	27	cubic feet
Cubic yards	46,656	cubic inches
Cubic yards	0.7646	cubic meters
Cubic yards	202.0	gallons
Cubic yards	764.6	liters
Cubic yards	1616	pints (liquid)
Cubic yards	807.9	quarts (liquid)
Cubic yards per minute	0.45	cubic feet per second
Cubic yards per minute	3.367	gallons per second
Cubic yards per minute	12.74	liters per second
Days	24	hours
Days	1440	minutes
Days	86,400	seconds
Decigrams	0.1	grams
MULTIPLY	BY	TO OBTAIN
Deciliters	0.1	liters
Decimeters	0.1	meters
Degrees (angle)	60	minutes
Degrees (angle)	0.01745	radians
Degrees (angle)	3600	seconds
Degrees per second	0.01745	radians per second
Degrees per second	0.1667	revolutions per minute
Degrees per second	0.002778	revolutions per second
Dekagrams	10	grams
Dekaliters	10	liters
Dekameters	10	meters
Drams	1.772	grams
Drams	0.0625	ounces
Dynes	1.020×10^{-3}	grams
Dynes	7.233×10^{-5}	poundals
Dynes	2.248×10^{-6}	pounds
Dynes per square cm	1	bars
Ergs	9.486×10^{-11}	British thermal units
Ergs	1	dyne-centimeters
Ergs	7.376×10^{-8}	foot-pounds
Ergs	1.020×10^{-3}	gram-centimeters
Ergs	10^{-7}	joules
Ergs	2.390×10^{-11}	kilogram-calories
Ergs	1.020×10^{-8}	kilogram-meters
Ergs per second	5.692×10^{-9}	BTU per minute
Ergs per second	4.426×10^{-6}	foot-pounds per minute
Ergs per second	7.376×10^{-8}	foot-pounds per second
Ergs per second	1.341×10^{-10}	horsepower
Ergs per second	1.434×10^{-9}	kg.-calories per minute
Ergs per second	10^{-10}	kilowatts
Fathoms	6	feet
Feet	30.48	centimeters
Feet	12	inches
Feet	0.3048	meters

Feet	36	varas
Feet	1/3	yards
Feet of water	0.02950	atmospheres
Feet of water	0.8826	inches of mercury
Feet of water	304.8	kgs. per square meter
Feet of water	62.43	pounds per square foot
Feet of water	0.4335	pounds per square inch
MULTIPLY	BY	TO OBTAIN
Feet per minute	0.5080	centimeters per second
Feet per minute	0.01667	feet per second
Feet per minute	0.01829	kilometers per hour
Feet per minute	0.3048	meters per minute
Feet per minute	0.01136	miles per hours
Feet per second	30.48	centimeters per second
Feet per second	1.097	kilometers per hour
Feet per second	0.5921	knots per hour
Feet per second	18.29	meters per minute
Feet per second	0.6818	miles per hour
Feet per second	0.01136	miles per minute
Feet per 100 feet	1	percent grade
Feet per sec per sec	30.48	cms. per second per second
Feet per sec per sec	1.097	kms. per hour per second
Feet per sec per sec	0.3048	meters per second per second
Feet per sec per sec	0.6818	miles per hour per second
Foot-pounds	1.268×10^{-3}	British thermal unit
Foot-pounds	1.356×10^7	ergs
Foot-pounds	5.050×10^{-7}	horsepower-hours
Foot-pounds	1.356	joules
Foot-pounds	3.241×10^{-4}	kilogram-calories
Foot-pounds	0.1383	kilogram-meters
Foot-pounds	3.766×10^{-7}	kilowatt-hours
Foot-pounds per minute	1.286×10^{-3}	BTU per minute
Foot-pounds per minute	0.01667	foot-pounds per second
Foot-pounds per minute	3.030×10^{-5}	horsepower
Foot-pounds per minute	3.241×10^{-4}	kg.-calories per minute
Foot-pounds per minute	2.260×10^{-5}	kilowatts
Foot-pounds per second	7.717×10^{-2}	BTU per minute
Foot-pounds per second	1.818×10^{-3}	horsepower
Foot-pounds per second	1.945×10^{-8}	kg.-calories per minute
Foot-pounds per second	1.356×10^{-3}	kilowatts
Furlongs	40	rods
Gallons	3,785	cubic centimeters
Gallons	0.1337	cubic feet
Gallons	231	cubic inches
Gallons	3.785×10^{-3}	cubic meters
Gallons	4.851×10^{-3}	cubic yards
Gallons	3.785	liters
Gallons	8	pints (liquid)
Gallons	4	quarts (liquid)

MULTIPLY	BY	TO OBTAIN
Gallons per minute	2.228×10^{-3}	cubic feet per second
Gallons per minute	0.06308	liters per second
Gills	0.1183	liters
Gills	0.25	pints (liquid)
Grains (troy)	1	grains (av.)
Grains (troy)	0.06480	grams
Grains (troy)	0.04167	pennyweights (troy)
Grams	980.7	dynes
Grams	15.43	grains (troy)
Grams	10^{-3}	kilograms
Grams	10^3	milligrams
Grams	0.03527	ounces
Grams	0.03215	ounces (troy)
Grams	0.07093	poundals
Grams	2.205×10^{-3}	pounds
Gram-calories	3.968×10^{-3}	British thermal units
Gram-centimeters	9.302×10^{-3}	British thermal units
Gram-centimeters	980.7	ergs
Gram-centimeters	7.233×10^{-3}	foot-pounds
Gram-centimeters	9.807×10^{-5}	joules
Gram-centimeters	2.344×10^{-8}	kilogram-calories
Gram-centimeters	10^{-5}	kilogram-meters
Grams per cm	5.600×10^{-3}	pounds per inch
Grams per cubic cm	62.43	pounds per cubic foot
Grams per cubic cm	0.3613	pounds per cubic inch
Grams per cubic cm	3.405×10^{-7}	pounds per mil-foot
Hectares	2.471	acres
Hectares	1.076×10^5	square feet
Hectograms	100	grams
Hectoliters	100	liters
Hectometers	100	meters
Hectowatts	100	watts
Hemispheres (sol. angle)	0.5	sphere
Hemispheres (sol. angle)	4	spherical right angles
Hemispheres (sol. angle)	6.283	steradians
Horsepower	42.44	BTU per minute
Horsepower	33,000	foot-pounds per minute
Horsepower	550	foot-pounds per second
Horsepower	1.014	horsepower (metric)
Horsepower	10.70	kg.-calories per minute

MULTIPLY	BY	TO OBTAIN
Horsepower	0.7457	kilowatts
Horsepower	745.7	watts
Horsepower (boiler)	33,520	BTU per hour
Horsepower (boiler)	9.804	kilowatts
Horsepower-hours	2,547	British thermal units
Horsepower-hours	1.98×10^6	foot-pounds
Horsepower-hours	2.684×10^6	joules
Horsepower-hours	641.7	kilogram-calories
Horsepower-hours	2.737×10^5	kilogram-meters
Horsepower-hours	0.7457	kilogram-hours
Hours	60	minutes
Hours	3,600	seconds
Inches	2.540	centimeters
Inches	10^3	mils
Inches	.03	varas
Inches of mercury	0.03342	atmospheres
Inches of mercury	1.133	feet of water
Inches of mercury	345.3	kgs. per square meter
Inches of mercury	70.73	pounds per square foot
Inches of mercury	0.4912	pounds per square inch
Inches of water	0.002458	atmospheres
Inches of water	0.07355	inches of mercury
Inches of water	25.40	kgs. per square meter
Inches of water	0.5781	ounces per square inch
Inches of water	5.204	pounds per square foot
Inches of water	0.03613	pounds per square inch
Joules	9.486×10^{-4}	British thermal unit
Joules	10^7	ergs
Joules	0.7376	foot-pounds
Joules	2.390×10^{-4}	kilograms-calories
Joules	0.1020	kilograms-meters
Joules	2.778×10^{-4}	watt-hours
Kilograms	980,665	dynes
Kilograms	10^3	grams
Kilograms	70.93	poundals
Kilograms	2.2046	pounds
Kilograms	1.102×10^{-3}	tons (short)
Kilogram-calories	3.968	British thermal units

MULTIPLY	BY	TO OBTAIN
Kilogram-calories	3,088	foot-pounds
Kilogram-calories	1.588×10^{-3}	horsepower hours
Kilogram-calories	4,183	joules
Kilogram-calories	426.6	kilogram-meters
Kilogram-calories	1.162×10^{-3}	kilowatt-hours
Kg.-calories per min	51.43	foot-pounds per second
Kg.-calories per min	0.09351	horsepower
Kg.-calories per min	0.06972	kilowatts
Kgs. cms. squared	2.373×10^{-3}	pounds-feet squared
Kgs. cms. squared	0.3417	pounds-inches squared
Kilogram-meters	9.302×10^{-3}	British thermal units
Kilogram-meters	9.807×10^7	ergs
Kilogram-meters	7.233	foot-pounds
Kilogram-meters	9.807	joules
Kilogram-meters	2.344×10^{-3}	kilogram-calories
Kilogram-meters	2.724×10^{-6}	kilowatt-hours
Kgs. per cubic meter	10^{-3}	grams per cubic cm.
Kgs. per cubic meter	0.06243	pounds per cubic foot
Kgs. per cubic meter	3.613×10^{-5}	pounds per cubic inch
Kgs. per cubic meter	3.405×10^{-10}	pounds per mil foot
Kgs. per meter	0.6720	pounds per foot
Kgs. per square meter	9.678×10^{-5}	atmospheres
Kgs. per square meter	98.07	bars
Kgs. per square meter	3.281×10^{-3}	feet of water
Kgs. per square meter	2.896×10^{-3}	inches of mercury
Kgs. per square meter	0.2048	pounds per square foot
Kgs. per square meter	1.422×10^{-3}	pounds per square inch
Kgs. per sq. millimeter	10^6	kgs. per square meter
Kilolines	10^3	maxwells
Kiloliters	10^3	liters
Kilometers	10^5	centimeters
Kilometers	3281	feet
Kilometers	10^3	meters
Kilometers	0.6214	miles
Kilometers	1093.6	yards
Kilometers per hour	27.78	centimeters per second
Kilometers per hour	54.68	feet per minute
Kilometers per hour	0.9113	feet per second
Kilometers per hour	0.5396	knots per hour
Kilometers per hour	16.67	meters per minute
Kilometers per hour	0.6214	miles per hour
MULTIPLY	BY	TO OBTAIN
Kms. per hour per sec	27.78	cms. per sec per sec
Kms. per hour per sec	0.9113	feet per sec per sec
Kms. per hour per sec	0.2778	meters per sec per sec
Kms. per hour per sec	0.6214	miles per hour per sec
Kilometers per minute	60	kilometers per hour
Kilowatts	56.92	BTU per minute
Kilowatts	4.425×10^4	foot-pounds per minute
Kilowatts	737.6	foot-pounds per second
Kilowatts	1.341	horsepower

Kilowatts	14.34	kg.-calories per minute
Kilowatts	10^3	watts
Kilowatt-hours	3415	British thermal unit
Kilowatt-hours	2.655×10^6	foot-pounds
Kilowatt-hours	1.341	horsepower-hours
Kilowatt-hours	3.6×10^6	joules
Kilowatt-hours	860.5	kilogram-calories
Kilowatt-hours	3.671×10^5	kilogram-meters
Knots	51.48	centimeters per second
Knots	1.689	feet per second
Knots	1.853	kilometers per hour
Knots	1.152	miles per hour
Links (engineer's)	12	inches
Links (surveyor's)	7.92	inches
Liters	10^3	cubic centimeters
Liters	0.03531	cubic feet
Liters	61.02	cubic inches
Liters	10^{-3}	cubic meters
Liters	1.308×10^{-3}	cubic yards
Liters	0.2642	gallons
Liters	2.113	pints (liquid)
Liters	1.057	quarts (liquid)
Liters per minute	5.885×10^{-4}	cubic feet per second
Liters per minute	4.403×10^{-3}	gallons per second
$\log_{10} N$	2.303	$\log_e N$ or $\ln N$
$\log_e N$ or $\ln N$	0.4343	$\log_{10} N$
Lumens per square foot	1	foot-candles
Meters	100	centimeters
Meters	3.2808	feet
Meters	39.37	inches

MULTIPLY	BY	TO OBTAIN
Meters	10^{-3}	kilometers
Meters	10^3	millimeters
Meter-kilograms	9.807×10^7	centimeter-dynes
Meter-kilograms	10^5	centimeter-grams
Meter-kilograms	7.233	pound-feet
Meters per minute	1.667	centimeters per second
Meters per minute	3.281	feet per minute
Meters per minute	0.5468	feet per second
Meters per minute	0.06	kilometers per hour
Meters per minute	0.03728	miles per hour
Meters per second	196.8	feet per minute
Meters per second	3.281	feet per second
Meters per second	3.6	kilometers per hour
Meters per second	0.06	kilometers per minute
Meters per second	2.237	miles per hour
Meters per second	0.3728	miles per minute
Meters per sec per sec	3.281	feet per sec per sec
Meters per sec per sec	3.6	kns. per hour per second
Meters per sec per sec	2.237	miles per hour per second
Microns	10^{-6}	meters
Miles	1.609×10^5	centimeters

MULTIPLY	BY	TO OBTAIN
Miles	5,280	feet
Miles	1.6093	kilometers
Miles	1,760	yards
Miles	1900.8	varas
Miles per hour	44.70	centimeters per second
Miles per hour	88	feet per minute
Miles per hour	1.467	feet per second
Miles per hour	1.6093	kilometers per hour
Miles per hour	0.8690	knots per hour
Miles per hour	26.82	meters per minute
Miles per hour per sec	44.70	cms. per sec per sec
Miles per hour per sec	1.467	feet per sec per sec
Miles per hour per sec	1.6093	kms. per hour per sec
Miles per hour per sec	0.4470	M. per sec per sec
Miles per minute	2682	centimeters per second
Miles per minute	88	feet per second
Miles per minute	1.6093	kilometers per minute
Miles per minute	0.8684	knots per minute
Miles per minute	60	miles per hour
Milliers	10^3	kilograms
Milligrams	10^{-3}	grams

MULTIPLY	BY	TO OBTAIN
Milliliters	10^{-3}	liters
Millimeters	0.1	centimeters
Millimeters	0.03937	inches
Millimeters	39.37	mils
Mils	0.002540	centimeters
Mils	10^{-3}	inches
Miner's inches	1.5	cubic feet per minute
Minutes (angle)	2.909×10^{-4}	radians
Minutes (angle)	60	seconds (angle)
Months	20.42	days
Months	730	hours
Months	43,800	minutes
Months	2.628×10^6	seconds
Myriagrams	10	kilograms
Myriameters	10	kilometers
Myriawatts	10	kilowatts
Nautical miles	6067	feet
Nautical miles	1.852	kilometers
Nautical miles	1.151	miles
Nautical miles	2025	yards
Ounces	8	drams
Ounces	437.5	grains
Ounces	28.35	grams
Ounces	0.0625	pounds
Ounces (fluid)	1.805	cubic inches
Ounces (fluid)	0.02957	liters
Ounces (troy)	480	grains (troy)
Ounces (troy)	31.10	grams
Ounces (troy)	20	pennyweights (troy)

MULTIPLY	BY	TO OBTAIN
Ounces (troy)	0.08333	pounds (troy)
Ounces per square inch	0.0625	pounds per square inch
Pennyweights (troy)	24	grains (troy)
Pennyweights (troy)	1.555	grams
Pennyweights (troy)	0.05	ounces (troy)
Perches (masonry)	24.75	cubic feet
Pints (dry)	33.60	cubic inches
Pints (liquid)	28.87	cubic inches
Poundals	13,826	dynes
Poundals	14.10	grams

MULTIPLY	BY	TO OBTAIN
Poundals	0.03108	pounds
Pounds	444,823	dynes
Pounds	7,000	grains
Pounds	453.6	grams
Pounds	16	ounces
Pounds	32.17	poundals
Pounds (troy)	0.8229	pounds (av.)
Pound-feet	1.356×10^7	centimeter-dynes
Pound-feet	13,825	centimeter-grams
Pound-feet	0.1383	meter-kilograms
Pound-feet squared	421.3	kgs.-cms. squared
Pounds-feet squared	144	pounds-inches squared
Pounds-inches squared	2.926	kgs.-cms. squared
Pounds-inches squared	6.945×10^{-3}	pounds-feet squared
Pounds of water	0.01602	cubic feet
Pounds of water	27.68	cubic inches
Pounds of water	0.1198	gallons
Pounds of water per min	2.669×10^{-4}	cubic feet per second
Pounds per cubic foot	0.01602	grams per cubic cm.
Pounds per cubic foot	16.02	kgs. per cubic meter
Pounds per cubic foot	5.787×10^{-4}	pounds per cubic inch
Pounds per cubic foot	5.456×10^{-9}	pounds per mil foot
Pounds per cubic inch	27.68	pounds per cubic cm.
Pounds per cubic inch	2.768×10^4	kgs. per cubic meter
Pounds per cubic inch	1728	pounds per cubic foot
Pounds per cubic inch	9.425×10^{-6}	pounds per mil foot
Pounds per foot	1.488	kgs. per meter
Pounds per inch	178.6	grams per cm.
Pounds per mil foot	2.306×10^8	grams per cubic cm.
Pounds per square foot	0.01602	feet of water
Pounds per square foot	4.882	kgs. per square meter
Pounds per square foot	6.944×10^{-3}	pounds per square inch
Pounds per square inch	0.06804	atmospheres
Pounds per square inch	2.307	feet of water
Pounds per square inch	2.036	inches of mercury
Pounds per square inch	703.1	kgs. per square meter
Pounds per square inch	144	pounds per square foot
Quadrants (angle)	5400	minutes
Quadrants (angle)	1.571	radians
Quarts (dry)	67.20	cubic inches

MULTIPLY	BY	TO OBTAIN
Quarts (liquid)	57.75	cubic inches
Quintals	100	pounds
Quires	25	sheets
Radians	57.30	degrees
Radians	3438	minutes
Radians	0.637	quadrants
Radians per second	57.30	degrees per second
Radians per second	0.1592	revolutions per second
Radians per second	9.549	revolutions per minute
Radians per sec per sec	573.0	revs. per min per min
Radians per sec per sec	9.549	revs. per min per sec
Radians per sec per sec	0.1592	revs. per sec per sec
Reams	500	sheets
Revolutions	360	degrees
Revolutions	4	quadrants
Revolutions	6.283	radians
Revolutions per minute	6	degrees per second
Revolutions per minute	0.1047	radians per second
Revolutions per minute	0.01667	revolutions per second
Revs. per min per min	1.745×10^{-3}	rads. per sec per sec
Revs. per min per min	0.01667	revs. per min per sec
Revs. per min per min	2.778×10^{-4}	revs. per sec per sec
Revolutions per second	360	degrees per second
Revolutions per second	6.283	radians per second
Revolutions per second	60	revs. per minute
Revs. per sec per sec	6.283	rads. per sec per sec
Revs. per sec per sec	3600	revs. per min per min
Revs. per sec per sec	60	revs. per min per sec
Rods	16.5	feet
Seconds (angle)	4.848×10^{-6}	radians
Spheres (solid angle)	12.57	steradians
Spherical right angles	0.25	hemispheres
Spherical right angles	0.125	spheres
Spherical right angles	1.571	steradians
Square centimeters	1.973×10^5	circular mils
Square centimeters	1.076×10^{-3}	square feet
Square centimeters	0.1550	square inches
Square centimeters	10^{-6}	square meters
Square centimeters	100	square millimeters
Square feet	2.296×10^{-5}	acres
MULTIPLY	BY	TO OBTAIN
Square feet	929.0	square centimeters
Square feet	144	square inches
Square feet	0.09290	square meters
Square feet	3.587×10^{-8}	square miles
Square feet	0.1296	square varas
Square feet	1/9	square yards
Sq. feet-feet sqd	2.074×10^4	sq. inches-inches sqd
Square inches	1.273×10^6	circular mils

MULTIPLY	BY	TO OBTAIN
Square inches	6.452	square centimeters
Square inches	6.994×10^{-3}	square feet
Square inches	10^5	square mils
Square inches	645.2	square millimeters
Sq. inches-inches sqd	41.62	sq. cms.-cms.sqd
Sq. inches-inches sqd	4.823×10^{-5}	sq. feet-feet sqd
Square kilometers	247.1	acres
Square kilometers	10.76×10^6	square feet
Square kilometers	10^6	square meters
Square kilometers	0.3861	square miles
Square kilometers	1.196×10^6	square yards
Square meters	2.471×10^{-4}	acres
Square meters	10.764	square feet
Square meters	3.861×10^{-7}	square miles
Square meters	1.196	square yards
Square miles	640	acres
Square miles	27.88×10^6	square feet
Square miles	2.590	square kilometers
Square miles	3,613,040.45	square yards
Square miles	3.098×10^6	square yards
Square millimeters	1.973×10^3	circular mils
Square millimeters	0.01	square centimeters
Square millimeters	1.550×10^{-3}	square inches
Square mils	1.273	circular mils
Square mils	6.452×10^{-6}	square centimeters
Square mils	10^{-6}	square inches
Square varas	0.0001771	acres
Square varas	7.716049	square feet
Square varas	0.0000002765	square miles
Square varas	0.857339	square yards
Square yards	2.066×10^{-4}	acres
Square yards	9	square feet
Square yards	0.8361	square meters
Square yards	3.228×10^{-7}	square miles

MULTIPLY	BY	TO OBTAIN
Square yards	1.1664	square varas
Steradians	0.1592	hemispheres
Steradians	0.07958	spheres
Steradians	0.6366	spherical right angles
Sterres	10^3	liters
Temp. (deg. C) +273	1	abs. tem (deg. C)
Temp. (deg. C) +17.8	1.8	temp. (deg. F)
Temp. (deg. F) +460	1	abs. temp (deg. F)
Temp. (deg. F) -32	5/9	temp. (deg. C)
Tons (long)	1016	kilograms
Tons (long)	2240	pounds
Tons (metric)	10^3	kilograms
Tons (metric)	2205	pounds
Tons (short)	907.2	kilograms
Tons (short)	2000	pounds
Tons (short) per sq. ft.	9765	kgs. per square meter
Tons (short) per sq. ft.	13.89	pounds per square inch

MULTIPLY	BY	TO OBTAIN
Tons (short) per sq. ft.	1.406×10^6	kgs. per square meter
Tons (short) per sq. ft.	2000	pounds per square inch
Varas	2.7777	feet
Varas	33.3333	inches
Varas	0.000526	miles
Varas	0.9259	yards
Watts	0.05692	BTU per minute
Watts	10^7	ergs per second
Watts	44.26	foot-pounds per minute
Watts	0.7376	foot-pounds per second
Watts	1.341×10^{-3}	horsepower
Watts	0.01434	kg.-calories per minute
Watts	10^2	kilowatts
Watt-hours	3.415	British thermal unit
Watt-hours	2655	foot-pounds
Watt-hours	1.341×10^{-3}	horsepower-hours
Watt-hours	0.8605	kilogram-calories
Watt-hours	367.1	kilogram-meters
Watt-hours	10^{-2}	kilowatt-hours
Webers	10^8	maxwells
Weeks	168	hours

MULTIPLY	BY	TO OBTAIN
Weeks	10,080	minutes
Weeks	604,800	seconds
Yards	91.44	centimeters
Yards	3	feet
Yards	36	inches
Yards	0.9144	meters
Yards	1.08	varas
Years (common)	365	days
Years (common)	8760	hours
Years (leap)	366	days
Years (leap)	8784	hours

FOREIGN WEIGHTS AND MEASURES

Denominations	Where Used	American Equivalents
Almude	Portugal	4.422 gals.
Ardeb	Egypt	5.6188 bu.
Are	metric	0.02471 acre.
Arr't'l or li'ra	Portugal	1.0119 lbs.
Arroba	Argentine Republic	25.32 lbs.
Arroba	Brazil	32.38 lbs.
Arroba	Cuba	25.36 lbs.
Arroba	Paraguay	25.32 lbs.
Arroba	Venezuela	25.40 lbs.
Arroba (liquid)	Cuba, Spain and Venezuela	4.263 gals.
Arshine	Russia	28 in.
Arshine (sq.)	Russia	5.44 ft. ²
Artel	Morocco	1.12 lbs.
Baril	Argentine Republic and Mexico	20.077 gals. 20.0787 gals.
Barrel	Malta (customs)	11.2 gals.
Berkovets	Russia	361.128 lbs.
Bongkal	Fed. Malay States	832 grains
Bouw	Sumatra	7,096.5 meters ²
Bu	Japan	0.12 inch
Bushel	British Empire	1.03205 U.S. bu.
Caffiso	Malta	5.40 gals.
Candy	India (Bombay)	569 lbs.
Candy	India (Madras)	500 lbs.
Cantar	Egypt	99.05 lbs.
Cantar	Morocco	112 lbs.
Cantar	Turkey	124.45 lbs.
Cantaro	Malta	175 lbs.
Cast, Metric	Metric	3.086 grains
Catty	China	1.333 1/3 lbs.
Catty	Japan	1.32 lbs.
Catty	Java, Malacca	1.36 lbs.
Catty	Thailand	2 2/3 lbs.
Catty (stand)	Thailand	1.32 lbs.
Catty	Sumatra	2.12 lbs.
Centaro	Central America	4.2631 gals.
Centner	Brunswick	117.5 lbs.
Centner	Bremen	127.5 lbs.
Centner	Denmark, Norway	110.23 lbs.
Centner	Prussia	113.44 lbs.
Centner	Sweden	93.7 lbs.
Centner	Double or metric	220.46
Chetvert	Russia	5.957 bu.
Ch'ih	China	12.60 in.

Denominations	Where Used	American Equivalents
Ch'ih (metric)	China	1 meter
Cho	Japan	2.451 acres
Comb	England	4.1282 bu.
Coyan	Thailand	2.645.5 lbs.
Cuadra	Argentine Republic	4.2 acres
Cuadra	Paraguay	94.70 yds.
Cuadra (sq.)	Paraguay	1.85 acres
Cuadra	Uruguay	1.82 acres
Cubic meter	Metric	35.3 cu. ft.
Cwt. (hund. weight)	British	112 lbs.
Dessiatine	Russia	2.6997 acres
Drachma (new)	Greece	15.43 gr., or 1 gram
Fanega (dry)	Ecuador, Salvador	1.5745 bu.
Fanega	Chile	2.75268 bu.
Fanega	Guatemala, Spain	1.53 bu.
Fanega	Mexico	2.57716 bu.
Fanega (double)	Uruguay	7.776 bu.
Fanega (single)	Uruguay	3.888 bu.
Fanega	Venezuela	3.334 bu.
Fanega (liquid)	Spain	16 gals.
Feddan	Egypt	1.04 acres
Frall (rais's)	Spain	50 lbs.
Frasco	Argentine Republic	2.5098 liq. qts.
Frasco	Mexico	2.5 liq. qts.
Frasila	Zanzibar	35 lbs.
Fuder	Luxemburg	264.18 gals.
Funt	Russia	0.9028 lb.
Gallon	British Empire	1.20094 U.S. gal.
Garnice	Poland	1.0567 gal.
Gram	Metric	15.432 grains
Hectare	Metric	2.471 acres
Hectolitre: Dry	Metric	2.838 bu.
Hectolitre: Liquid	Metric	26.418 gals.
Jarib	Iran	2.471 acres
Joch	Austria (Germany)	1.422 acres
Joch	Hungary	1.067 acres
Ken	Japan	5.97 feet
Kilogram (kilo)	Metric	2.2046 lbs.
Kilometre	Metric	0.62137 mile
Klafter	Austria (Germany)	2.074 yds.
Koku	Japan	5.119 bu.
Kwamme	Japan	8.2673 lbs.
Last	Belgium (Netherlands)	85.135 bu.
Last	England	82.56 bu.
Last	Germany	2 metric tons (4,409 + lbs)
Last	Prussia	112.29 bu.
Last	Scotland, Ireland	82.564 bu.
League (land)	Paraguay	4.633 acres
Li	China	1,890 ft.

Denominations	Where Used	American Equivalents
Libra (lb.)	Argentine Republic	1.0128 lbs.
Libra	Central America	1.014 lbs.
Libra	Chile	1.014 lbs.
Libra	Cuba	1.0143 lbs.
Libra	Mexico	1.01467 lbs.
Libra	Peru	1.0143 lbs.
Libra	Uruguay	1.0143 lbs.
Libra	Venezuela	1.0143 lbs.
Litre	Metric	1.0567 liq. qts.
Litre	Metric	0.90810 dry qts.
Livre (lb.)	Greece	1.1 lbs
Load, timber	England	50 cu. ft.
Lumber (std.)	Europe	165 cu. ft., or 1,980 ft.b.m.
Manzana	Nicaragua	1.742 acres
Manzana	Costa Rica, Salvador	1.727 acres
Marc	Bolivia	0.507 lb.
Maund	India	82 2/7 lbs.
Metre	Metric	39.37 inches
Mil	Denmark	4.68 miles
Mil (geographic)	Denmark	4.61 miles
Milla	Nicaragua	1.1594 miles
Milla	Honduras	1.1493 miles
Mina (old)	Greece	2.202 lbs.
Morgen	Germany	0.63 acre
Oke	Egypt	2.8052 lbs
Oke (Ocque)	Greece	2.82 lbs.
Oke	Turkey	2.828 lbs.
Pic	Egypt	22.82 inches
Picul	Borneo, Celebes	135.64 lbs.
Picul	China	133 1/3 lbs.
Picul	Java	136.16 lbs.
Picul	Philippines	139.44 lbs.
Pie	Argentine Republic	0.94708 ft.
Pie	Spain	0.91416 ft.
Pik	Turkey	27.9 inches
Pood	Russia	36.113 lbs.
Pund (lb)	Denmark	1.102 lbs.
Quart	British Empire	1.20094 liq. qt.
Quart	British Empire	1.03205 dry qt.
Quarter	Great Britian	8.256 bu.
Quintal	Argentine Republic	101.28 lbs.
Quintal	Brazil	120.54 lbs.
Quintal	Castle, Peru	101.43 lbs.
Quintal	Chile	101.41 lbs.
Quintal	Mexico	101.47 lbs.
Quintal	Metric	220.46 lbs.
Rottle	Israel	6.35 lbs.
Sack (flour)	England	280 lbs.
Sangene	Russia	7 feet

Denominations	Where Used	American Equivalents
Salm	Malta	8.2 bu.
Se	Japan	0.02451 acre
Seer	India	22-35 lbs.
Shaku	Japan	11.9303 inches
Sho	Japan	1.91 liq. qts.
Skalpund	Sweden	0.937 lbs.
Stone	British	14 lbs.
Sun	Japan	1.193 inches
Tael Kuping	China	575.64 grs. (troy)
Tan	Japan	2.05 pecks
Tchvtert	Russia	5.96 bu.
To	Japan	2.05 pecks
Ton	Space measure	40 cu ft.
Tonde cereals	Denmark	3.9480 bu.
Tonde Land	Denmark	1.36 acres
Tonne	France	2204.62 lbs.
Tsubo	Japan	35.58 ft. ²
Tsun	China	1.26 inches
Tunna (wheat)	Sweden	4.5 bu.
Tunnland	Sweden	1.22 acres
Vara	Argentine Republic	34.0944 inches
Vara	Costa Rita, Salvador	32.913 inches
Vara	Guatemala	32.909 inches
Vara	Honduras	32.953 inches
Vara	Nicaragua	33.057 inches
Vara	Chile and Peru	32.913 inches
Vara	Cuba	33.386 inches
Vara	Mexico	32.992 inches
Vedro	Russia	2.707 gals.
Verst	Russia	0.663 mile
Vloka	Poland	41.50 acres
Wey	Scotland and Ireland	41.282 bu.

CIVIL ENGINEER TEAM STRUCTURE

The following civil engineer teams were developed to meet the many diverse engineer tasks projected for theater wartime operations under deterrent and warfighting conditions. These tasks range from expedient beddown construction and base recovery to crash rescue/fire suppression and sustained operations and maintenance activities.

CES Prime BEEF Disaster Preparedness High Threat Augmentation Team

UTC 4F9D1	Strength: Officer 00	Amn 02	Total 02
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Provides manning for 24 hours NBC warfare defense operations to include command and control, detection, monitoring, identification, marking, analysis, plotting, and reporting. Capable of operating assigned NBC detection, warning, and identification equipment. This is not a stand-alone team and must be deployed with other DP personnel and a 4F9D2 equipment package per location.

CES Prime BEEF Disaster Preparedness High Threat Equipment

UTC 4F9D2	Strength: Officer 00	Amn 00	Total 00
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Provides Nuclear, Biological, Chemical, and Conventional (NBCC) defense equipment to support DP operations/personnel. The package provides NBC detection and monitoring equipment, computer/communications package, Survival Recovery Center/Contingency Support Staff, Disaster Control Center (DCC) equipment and supplies, contamination control area capabilities, as well as limited protective mask repair and replacement parts.

CES Prime BEEF Lead Team

UTC 4F9E5	Strength: Officer 06	Amn 126	Total 132
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Active duty engineer, fire protection, and disaster preparedness force to support regional conflict missions at contingency operating locations, aerial ports, en-route bases, or critical stateside bases. Provides initial beddown for up to 1200 personnel and a lead aviation squadron using expedient or existing facilities as well as sustainment support of facilities and utilities. When provided with 2 P-19s, 1 P-20, and 1 P-10 (or equivalent fire vehicles), provides 24-hour aircraft firefighting support and limited structural, fuel and munitions fire support. Provides command and control; coordinates conventional warfare survivability and defense; and coordinates nuclear, biological, and chemical warfare defense. Individual mobility equipment; consolidated tool kits; firefighter protective clothing; team kit and equipment; and DP/NBC support equipment are required.

CES Prime BEEF ANG/AFRES Lead Team

UTC 4F9E6	Strength: Officer 06	Amn 105	Total 111
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AF Reserve and Air National Guard engineer and DP force to support regional conflict missions at contingency operating locations, aerial ports, en-route bases, or critical CONUS bases. Provides initial beddown for up to 1200 personnel and a lead squadron using expedient or existing facilities, and sustainment support of facilities and utilities. When combined with 1 4F9F3 and associated fire vehicles, provides 24-hour aircraft firefighting support and limited structural, fuel, and munitions fire support. Provides engineer command and control, coordinates conventional warfare survivability and defense, and coordinates NBC warfare defense. Individual mobility equipment, consolidated tool kits, team kit and equipment, and DP/NBC support equipment are required.

CES Prime BEEF Follow Team

UTC 4F9E7	Strength: Officer 02	AMN 59	Total 61
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Active Duty engineer, fire protection, and DP force to support regional conflict missions at contingency operating location, aerial port, en-route base, or critical CONUS base. Augments 4F9E5/6 to provide beddown support using expedient or existing facilities as well as sustainment support of facilities and utilities for lead/follow (L/F) squadrons. When combined with 4F9E5/6 and provided an additional P-19 fire truck, provides 24-hour aircraft fire support for L/F squadrons and limited structural, fuel, and munitions fire support. Enables 4F9E5/6 to provide 24-hour engineer command and control; coordinate conventional warfare survivability and defense; coordinate NBC warfare defense; and conduct DP training. Individual mobility equipment; consolidated tool kits; firefighter protective clothing; team kit and equipment; and DP/NBC support equipment required.

CES Prime BEEF ANG/AFRES Follow Team

UTC 4F9E8	Strength: Officer 02	AMN 53	Total 55
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ANG/AFRES engineer and DP force to support regional conflict missions at contingency operating locations, aerial port, en-route base, or critical CONUS base. Augments 4F9E5/6 to provide beddown support using expedient or existing facilities and sustainment support of facilities and utilities for a lead/follow (L/F) squadron. When combined with 4F9F3/F4 and associated vehicles, provides 24-hour firefighting support for a L/F squadron and limited structural, fuel and munitions fire support. Extends the capability of a lead team to provide 24-hour command and control, coordinate conventional warfare survivability and defense, coordinate NBC warfare defense, and conduct DP training. Individual mobility equipment, consolidated tool kits, team kit and equipment, and DP/NBC support equipment are required.

CES Prime BEEF ANG/AFRES Lead Fire Team

UTC 4F9F3	Strength: Officer 00	AMN 24	Total 24
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Fire protection team capable of supporting regional conflict missions at contingency operating locations, aerial ports, en-route bases, or critical stateside bases. When provided with two P-4/19s, one P-13/20, and one P-10 (or equivalent), team is capable of providing 24-hour aircraft operations. Can also provide limited support for structural, POL, and munitions fires. Capable of its own crash rescue/fire suppression command and control. Firefighter protective clothing and individual mobility equipment required.

CES Prime BEEF ANG/AFRES Follow Fire Team

UTC 4F9F4	Strength: Officer 00	AMN 12	Total 12
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Fire protection team capable of supporting regional conflict missions at contingency operating locations, aerial ports, en-route bases, or critical stateside bases. Augments a 4F9E5/6 or 4F9F3 and when provided an additional P-19 (or equivalent fire vehicle), provides 24-hour aircraft firefighting support for a lead and follow squadron and limited structural, fuel, and munitions fire support. Firefighter protective clothing and individual mobility equipment are required.

CES Prime BEEF CEMIRT Depot Maintenance Team

UTC 4F9AC	Strength: Officer 00	AMN 07	Total 07
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Engineer force to provide depot level maintenance of major electrical power generation and distribution systems and mobile and fixed aircraft arresting systems for regional conflict operations at contingency operating locations, aerial ports, en-route bases, or critical stateside bases. Team capabilities range from routine calibration to emergency maintenance and repair to major overhaul and repair of both real property and non-real property installed equipment. Provides technical assistance in conducting electrical system infrared surveys, troubleshoots electrical and mechanical system faults, diagnoses problems and determines solutions.

CES Prime BEEF Pavements Evaluation Team

UTC 4F9AD	Strength: Officer 01	AMN 03	Total 04
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Engineer force to provide technical expertise and guidance for the design, construction and repair of airfield pavements in support of regional conflict operations at contingency operating locations, aerial ports, en-route bases, or critical stateside bases. Uses destructive and non-destructive techniques to evaluate pavement structural integrity. Also conducts force beddown site selection surveys.

CES Prime BEEF Self-Sustainability Package

UTC 4F9AF	Strength: Officer 00	AMN 00	Total 00
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Supplemental Prime BEEF engineer team kit to increase the self-sustainability of a deployed Prime BEEF Follow team to seven days. Allows capability for feeding, limited power generation, billeting, communications, and command and control, for the full range of military operations when team is employed separately from a major Air Force operational deployment.

RHS RED HORSE RH-1 Team

UTC 4F9GA	Strength: Officer 02	AMN 14	Total 16
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Engineer force to perform advanced airfield surveys, site layout, and planning for the orderly establishment and future development of an operating location during contingencies. Contains site development and field engineering. Self-sustaining when combined with RH-2 team (UTC 4F9HA) and resupplied.

RHS RED HORSE RH-2 Team

UTC 4F9HA	Strength: Officer 03	AMN 91	Total 94
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Engineer force to perform light base development including installation of aircraft arresting systems, essential utility system, and basic shelters (Harvest Eagle/Falcon), temporary pavement repair/upgrade, bomb damage repair, and limited earthwork for land clearing and ammunition storage area during initial phase of contingencies. Organic functions include: vehicle/equipment operations and maintenance, electrical/mechanical, structural/pavement, work control, sanitation, supply, administration, disaster preparedness and medical. Food service deploys with five days of rations. Self-sustained operations for short durations with resupply of consumables (food, fuel, water).

RHS RED HORSE RH-3 Team

UTC 4F9JA	Strength: Officer 12	AMN 282	Total 294
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Engineer force to perform heavy repair of enemy inflicted or otherwise damaged facilities, aircraft shelter and other protective facility erection, airfield expansion, relocatable and facility substitute erection, and expansion of theater of operations facilities and utility systems. Possesses organic heavy equipment which requires surface movement or C-5 airlift. Self-sustained operations for short durations with resupply of consumables (food, fuel, water).

CES Prime BEEF Fire Protection Staff Augmentation Team

UTC 4F9S4	Strength: Officer 00	AMN 03	Total 03
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Fire Protection force to provide Unified Command, Major Command, Numbered Air Force, or Combined/Joint Task Force command staff augmentation for command and control, fire prevention, and logistics support for regional contingencies.

CES Prime BEEF Staff Augmentation Team

UTC 4F9S6	Strength: Officer 10	AMN 02	Total 12
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Engineer force to provide Unified Command, Major Command, Numbered Air Force, or Combined/Joint Task Force command staff augmentation for engineer management, technical design, construction management, command and control, and reporting in support of regional contingencies.

CES Prime BEEF EOD Lead Team

UTC 4F9X1	Strength: Officer 00	AMN 06	Total 06
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EOD force to support regional conflict missions at contingency operating locations, aerial ports, en-route bases, or critical stateside bases. Supports lead aviation squadron by protecting resources and personnel from the effects of explosive hazards, minor munitions accidents, clandestine explosive devices, and unexploded ordnance from limited attacks. Renders safe and disposes of US and foreign conventional, chemical, and improvised devices. Personnel will deploy with personal protective clothing, GUU-5 and M-9 weapons with ammunition.

CES Prime BEEF EOD Follow Team

UTC 4F9X2	Strength: Officer 00	AMN 04	Total 04
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EOD force to support regional conflict missions at contingency operating locations, aerial ports, en-route bases, or critical stateside bases. Augments a 4F9X1 to provide additive EOD support to lead/follow (L/F) squadrons. Provides independent limited EOD support, ordnance safing, and clearance operations at air heads, landing zones, and captured or recaptured bases and in similar operations other than war. Personnel will deploy with personal protective clothing, GUU-5 and M-9 weapons with ammunition.

CES Prime BEEF EOD Management Team

UTC 4F9X3	Strength: Officer 01	AMN 01	Total 02
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EOD management force to support regional conflict missions at contingency operating locations, aerial ports, en-route bases, or critical stateside bases where an EOD Lead team (UTC 4F9X1) and EOD Follow team(s) (UTC 4F9X2) already exist or are scheduled for deployment. Independently provides forward command functional management. Personnel will deploy with a base support equipment set, protective clothing and GUU-5 and M-9 weapons with ammunition.

CES Prime BEEF EOD High Threat Augmentation Team

UTC 4F9X9	Strength: Officer 00	AMN 02	Total 02
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EOD force required to support essential EOD warfighting requirements for regional conflict operations at contingency operating locations, aerial ports, and en-route bases. Augments 4F9X1, 4F9X2, and 4F9X3 supporting operations at deployed locations vulnerable to enemy aircraft or ballistic missile attack. Personnel will deploy with personal protective clothing and GUU-5 and M-9 weapons with ammunition.

CES Prime BEEF EOD Intelligence Exploitation Team

UTC 4F9XA	Strength: Officer 00	AMN 04	Total 04
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EOD force to conduct independent operations involving clearing entryways into munitions contaminated areas, identifying potentially exploitable munitions and safing ordnance for transport. Disassembles and develops field render safe and disposal procedures, and disseminates information to other units, Services, and intelligence gathering agencies. Personnel will deploy with personal protective equipment, GUU-5 and M-9 weapons with ammunition, and specialized support equipment.

CES Armored Base Recovery Vehicle

UTC 4F9X6	Strength: Officer 00	AMN 00	Total 00
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One armored Base Recovery Vehicle (BRV) complete with associated hand tools and specialized maintenance equipment. This UTC is used in multiples to provide EOD teams a mobile armored reconnaissance and UXO safing vehicle for BRAAT operations. High threat MOBs and COBs require six 4F9X6s. This UTC may be deployed by air; however, it is usually prepositioned or deployed by surface movements.

CES Armored Munitions Clearance Vehicle

UTC 4F9X7	Strength: Officer 00	AMN 00	Total 00
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One armored munitions clearance vehicle (MCV) complete with associated hand tools and specialized maintenance equipment. This UTC is used in multiples to provide EOD teams a heavily armored prime mover for specialized large area clearance operations during Base Recovery After Attack (BRAAT) which involve random delay, aircraft or artillery dispensed mines, and submunitions. High threat MOBs and COBs require three 4F9X7s. This UTC is usually prepositioned or deployed only by surface movements.

LABOR HOUR PLANNING

The following planning factors provide labor hour estimates for many of the common beddown related tasks. The task description is a general narrative explanation of the work to be performed. Alternate approaches to providing the same type of facility can apply, i.e., modification of an existing facility is considered a close approximation to providing an expedient facility (tent, hard wall shelter) of the same scope. The manhour estimates for each Air Force Specialty (AFS) are just that -- an approximation of the journeyman skills required to perform the work included in the description. Manhours assigned to AFS 3EXXX, unspecified labor, are labor intensive in nature and require no special skills aside from good physical condition. However, general civil engineer knowledge and supervision from other AFSs are assumed.

FACILITY TITLE: Dispersed Aircraft Parking

DESCRIPTION: Provides AM-2 matting for a 42 ft by 700 ft taxiway with five aircraft parking stubs and B-1 revetment to surround and protect each parking stub.

SCOPE: 6,400 sq yd

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E2X1 - Pavements and Construction Equipment	4,283
3E0X1 - Electrical Systems	40
3EXXX - Unspecified Labor	1,088
TOTAL LABOR HOURS REQUIRED	5,411

FACILITY TITLE: Air Transportable Hydrant Refueling System

DESCRIPTION: Air Transportable Hydrant Refueling System. 100,000-gal fuel storage capacity. 600 gal/min pressure controlled pumping capacity.

SCOPE: 2 outlets

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E2X1 - Pavements and Construction Equipment	176
3E4X2 - Liquid Fuels System Maintenance	20
3E5X1 - Engineering	4
3EXXX - Unspecified Labor	40
TOTAL LABOR HOURS REQUIRED	240

FACILITY TITLE: R-14 Fueling System

DESCRIPTION: R-14 Fueling System. 300,000-gal fuel storage capacity. 600 gal/min pressure controlled pumping capacity.

SCOPE: 1 system

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E2X1 - Pavements and Construction Equipment	256
3E4X2 - Liquid Fuels System Maintenance	36
3E5X1 - Engineering	6
3EXXX - Unspecified Labor	65
TOTAL LABOR HOURS REQUIRED	363

FACILITY TITLE: Operational Fuel Storage, 1,500,000-gal Bladder

DESCRIPTION: Provides thirty 50,000-gal collapsible fuel storage bladders, 600 gal/min pump, hose and all associated dispensing equipment for earth bermed facility.

SCOPE: 1,500,00 gal

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E2X1 - Pavements and Construction Equipment	770
3E3X1 - Structural	101
3X4X2 - Liquid Fuels System Maintenance	150
3E0X1 - Electrical Systems	8
3E4X1 - Utilities Systems	60
3E5X1 - Engineering	24
3EXXX - Unspecified Labor	<u>215</u>
TOTAL LABOR HOURS REQUIRED:	1,338

FACILITY TITLE: Operational Diesel Fuel Storage - 200,000-gal Bladder

DESCRIPTION: Provides four 50,000-gal storage bladders, nozzle dispensing stand, 600 gal/min meter and fuel filter assembly.

SCOPE: 200,000 gal

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E2X1 - Pavements and Construction Equipment	167
3E3X1 - Structural	28
3E4X2 - Liquid Fuels System Maintenance	20
3E5X1 - Engineering	6
3EXXX - Unspecified Labor	<u>21</u>
TOTAL LABOR HOURS REQUIRED:	242

FACILITY TITLE: Operating Fuel Storage - 80,000-gal Bladder

DESCRIPTION: Provides eight 10,000-gal fuel storage bladders, hydrant type refueling system with 600 gal/min center point refueling. Suitable for jet fuel or aviation gasoline.

SCOPE: 80,000 gal

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E2X1 - Pavements and Construction Equipment	95
3E4X2 - Liquid Fuels System Maintenance	30
3E5X1 - Engineering	12
3E0X1 - Electrical Systems	11
3EXXX - Unspecified Labor	<u>40</u>
TOTAL LABOR HOURS REQUIRED	188

FACILITY TITLE: POL Pipeline

DESCRIPTION: One mile of 6-inch grooved light weight tubing, with couplings, 2 gate and 2 check valves.

SCOPE: 1 mile, above ground

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E2X1 - Pavements and Construction Equipment	207
3E4X2 - Liquid Fuels system Maintenance	583
3E5X1 - Engineering	20
3EXXX - Unspecified Labor	<u>600</u>
TOTAL LABOR HOURS REQUIRED:	1,410

FACILITY TITLE: Trailer/Van Beddown

DESCRIPTION: Trailer/van beddown to include site preparation, camouflage, and necessary utility connections.

SCOPE: 9,000 SF

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E2X1 - Pavements and Construction Equipment	4
3E0X1 - Electrical Systems	8
3E5X1 - Engineering	<u>2</u>
TOTAL LABOR HOURS REQUIRED:	14

FACILITY TITLE: Mobile Control Tower

DESCRIPTION: Provides labor hours necessary to support setup and operation of mobile control tower.

SCOPE: 1,600 SF

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E2X1 - Pavements and Construction Equipment	2
3E1X1 - HVAC	2
3E0X1 - Electrical Systems	10
3E0X2 - Power Production	<u>8</u>
TOTAL LABOR HOUR REQUIREMENTS:	22

FACILITY TITLE: Emergency Airfield Lighting System (EALS)

DESCRIPTION: Installation of a system consisting of 10,000 feet of airfield lighting. Includes edge lights, approach lights, strobe lights, taxiway lights, miniPAPI lights, barrier marker lights along with necessary cable, controls, regulators and generators.

SCOPE: 10,000 feet

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E0X1 - Electrical Systems	16
3E0X2 - Power Production	<u>8</u>
TOTAL LABOR HOURS REQUIRED:	24

FACILITY TITLE: Expedient Aircraft Shelter

DESCRIPTION: Erect Harvest Falcon ACH with doors, flooring, and lighting.

SCOPE: 10,488 SF

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E2X1 - Pavements and Construction Equipment	24
3E3X1 - Structural	184
3E0X1 - Electrical Systems	8
3E0X2 - Power Production	8
3E5X1 - Engineering	12
3EXXX - Unspecified Labor	<u>244</u>
TOTAL LABOR HOURS REQUIRED:	480

FACILITY TITLE: Facility Revetment - Air Freight Terminal

DESCRIPTION: Provides for installation of 36 linear feet of 12-foot high revetment around a facility.

SCOPE: 36 linear feet

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E2X1 - Pavements and Construction Equipment	24
3EXXX - Unspecified Labor	<u>24</u>
TOTAL LABOR HOURS REQUIRED:	48

FACILITY TITLE: LOX - Mobile Unit

DESCRIPTION: Installation of mobile LOX plant.

SCOPE: 2,400 SF

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E2X1 - Pavements and Construction Equipment	260
3E1X1 - HVAC	12
3E0X2 - Power Production	4
3E5X1 - Engineering	4
3EXXX - Unspecified Labor	<u>252</u>
TOTAL LABOR HOURS REQUIRED:	532

FACILITY TITLE: Aircraft Revetment

DESCRIPTION: B-1 revetment kit, 16 feet high. Provides labor for placement of panels, filled with sand and capped with soil cement.

SCOPE: 252 linear feet

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E2X1 - Pavements and Construction Equipment	235
3E3X1 - Structural	205
3E5X1 - Engineering	6
3EXXX - Unspecified Labor	<u>244</u>
TOTAL LABOR HOURS REQUIRED:	684

FACILITY TITLE: Facility Revetments

DESCRIPTION: Provides labor hours for installing A-1 revetment kit to protect facilities. May be used in multiples to protect facilities of various outside dimensions. Revetment height is 12 feet.

SCOPE: 252 linear feet

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E2X1 - Pavements and Construction Equipment	120
3E3X1 - Structural	179
3E5X1 - Engineering	5
3EXXX - Unspecified Labor	<u>304</u>
TOTAL LABOR HOURS REQUIRED:	608

FACILITY TITLE: Aircraft Arresting Barrier

DESCRIPTION: Provides expeditionary installation of one skid-mounted BAK-12 aircraft arresting system suitable for installation on runways with 150, 200 or 300 foot widths. BAK-12 is rotary friction unit and incorporates two separate, independent brakes located one on each side of the runway interconnected by the cross-runway arresting cable.

SCOPE: 1 each

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E2X1 - Pavements and Construction Equipment	40
3EXXX - Unspecified Labor	20
3E0X2 - Power Production	40
3E5X1 - Engineering	<u>20</u>
TOTAL LABOR HOURS REQUIRED:	120

FACILITY TITLE: Defensive Fighting Position

DESCRIPTION: Provides a 7 by 7 by 7 foot wood frame bunker for protection of personnel engaged in base perimeter defense.

SCOPE: 49 SF

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E2X1 - Pavements and Construction Equipment	68
3EXXX - Unspecified Labor	<u>28</u>
TOTAL LABOR HOURS REQUIRED:	96

FACILITY TITLE: Aircraft Engine Shop

DESCRIPTION: Provides for alteration of existing building for use as an aircraft engine inspection and repair shop, 4,000 SF facility, including all necessary utility and mechanical systems.

SCOPE: 4,000 SF

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E2X1 - Pavements and Construction Equipment	10
3E3X1 - Structural	192
3E4X1 - Utilities	44
3E1X1 - HVAC	24
3E0X1 - Electrical Systems	4
3E5X1 - Engineering	<u>4</u>
TOTAL LABOR HOURS REQUIRED:	278

FACILITY TITLE: Facility Revetment - Engine Maintenance Shop

DESCRIPTION: Provides for installation of 360 linear feet of 12-foot high revetment around facility.

SCOPE: 360 linear feet

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E2X1 - Pavements and Construction Equipment	230
3E5X1 - Engineering	6
3EXXX - Unspecified Labor	<u>230</u>
TOTAL LABOR HOURS REQUIRED:	466

FACILITY TITLE: Field Level Maintenance Shop

DESCRIPTION: Provides for alteration of existing building for use as field level maintenance shop, 4,000 SF facility, including all necessary electrical, utility and mechanical systems.

SCOPE: 4,000 SF

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E2X1 - Pavements and Construction Equipment	10
3E3X1 - Structural	179
3E4X1 - Utilities	16
3E1X1 - HVAC	24
3E0X1 - Electrical Systems	19
3E5X1 - Engineering	<u>4</u>
TOTAL LABOR HOURS REQUIRED:	252

FACILITY TITLE: TEMPER Tent

DESCRIPTION: TEMPER tent erection, 4 sections.

SCOPE: 640 SF

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3EXXX - Unspecified Labor	<u>20</u>
TOTAL LABOR HOURS REQUIRED:	20

FACILITY TITLE: Harvest Falcon General Purpose Shelter

DESCRIPTION: General Purpose Shelter erection, includes floor and electrical.

SCOPE: 1488 SF

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E3X1 - Structural	40
3E0X1 - Electrical Systems	8
3EXXX - Unspecified Labor	<u>72</u>
TOTAL LABOR HOURS REQUIRED:	120

FACILITY TITLE: Harvest Falcon Expandable Shelter Container

DESCRIPTION: Expandable Shelter Container installation, includes electrical.

SCOPE: 275 SF

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E3X1 - Structural	2
3E0X1 - Electrical Systems	1
3EXXX - Unspecified Labor	<u>9</u>
TOTAL LABOR HOURS REQUIRED:	12

FACILITY TITLE: POL Storage Bladder, 952 bbl

DESCRIPTION: Provides four 10,000-gal collapsible fuel storage bladders, connections and earth berm.

SCOPE: 952 bbl

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E2X1 - Pavements and Construction Equipment	16
3E4X2 - Liquid Fuels System Maintenance	4
3E5X1 - Engineering	2
3EXXX - Unspecified Labor	<u>20</u>
TOTAL LABOR HOURS REQUIRED:	42

FACILITY TITLE: POL Storage Bladder, 238 bbl

DESCRIPTION: Provides one 10,000-gal collapsible fuel storage bladder, connections and earth berm.

SCOPE: 238 bbl

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E2X1 - Pavements and Construction Equipment	4
3E4X2 - Liquid Fuels System Maintenance	1
3EXXX - Unspecified Labor	<u>5</u>
TOTAL LABOR HOURS REQUIRED:	10

FACILITY TITLE: POL Storage Bladder, 71 bbl

DESCRIPTION: Provides one 3,000-gal collapsible fuel storage bladder, 20 gpm rotary fuel oil pump, fuel line with appurtenances and nozzle dispensing stand. Pump electrical 3/4 hp, 208v, 60Hz, 3-phase. Facility receives mogas or diesel fuel from tank trucks or trailers.

SCOPE: 71 bbl

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E2X1 - Pavements and Construction Equipment	2
3E0X1 - Electrical Systems	13
3E4X2 - Liquid Fuels System Maintenance	4
3E5X1 - Engineering	<u>2</u>
TOTAL LABOR HOURS REQUIRED:	21

FACILITY TITLE: POL Storage Bladder, 1,190 bbl

DESCRIPTION: Provides one 50,000-gal collapsible fuel storage bladder, connections and earth berm.

SCOPE: 1,190 bbl

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E2X1 - Pavements and Construction Equipment	24
3E4X2 - Liquid Fuels System Maintenance	4
3E5X1 - Engineering	4
3EXXX - Unspecified Labor	<u>16</u>
TOTAL LABOR HOURS REQUIRED:	48

FACILITY TITLE: Demineralized Water Unit

DESCRIPTION: Portable trailer-mounted unit capable of 600 gph, plus wood frame enclosure over unit.

SCOPE: 12,000 gal

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E2X1 - Pavements and Construction Equipment	2
3E3X1 - Structural	42
3E4X1 - Utilities	2
3E0X1 - Electrical Systems	<u>2</u>
TOTAL LABOR HOURS REQUIRED:	48

FACILITY TITLE: Facility Revetment - Ammunition Storage

DESCRIPTION: Provides for installation of 200 linear feet of 12-foot high revetment around open storage area.

SCOPE: 200 linear feet

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E2X1 - Pavements and Construction Equipment	128
3E5X1 - Engineering	4
3EXXX - Unspecified Labor	<u>128</u>
TOTAL LABOR HOURS REQUIRED:	260

FACILITY TITLE: Cold Storage

DESCRIPTION: Provides 150 cu ft prefabricated refrigerator with all necessary piping and electrical connections.

SCOPE: 150 cu ft

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E2X1 - Pavements and Construction Equipment	1
3E1X1 - HVAC	2
3E0X1 - Electrical Systems	<u>1</u>
TOTAL LABOR HOURS REQUIRED:	4

FACILITY TITLE: Cold Storage

DESCRIPTION: Provides 1200 cu ft of refrigerated cold storage with necessary electrical connections.

SCOPE: 1200 cu ft

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E2X1 - Pavements and Construction Equipment	2
3E1X1 - HVAC	4
3E0X1 - Electrical Systems	<u>2</u>
TOTAL LABOR HOURS REQUIRED:	8

FACILITY TITLE: General Purpose Tent, Large

DESCRIPTION: Erect General Purpose Tent, Large, with electrical.

SCOPE: 936 SF

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E0X1 - Electrical Systems	2
3EXXX - Unspecified Labor	<u>8</u>
TOTAL LABOR HOURS REQUIRED:	10

FACILITY TITLE: General Purpose Tent, Medium

DESCRIPTION: Erect General Purpose Tent, Medium, with electrical.

SCOPE: 512 SF

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E0X1 - Electrical Systems	1
3EXXX - Unspecified Labor	<u>3</u>
TOTAL LABOR HOURS REQUIRED:	4

FACILITY TITLE: Hardbacking - GP Medium Tent

DESCRIPTION: Construct hardbacking for GP Medium Tent.

SCOPE: 512 SF

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E3X1 - Structural	6
3EXXX - Unspecified Labor	<u>12</u>
TOTAL LABOR HOURS REQUIRED:	18

FACILITY TITLE: Harvest Falcon Shower/Shave Unit

DESCRIPTION: Setup Harvest Falcon shower/shave unit with tent, water heater, and utility connections.

SCOPE: 1 each

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E4X1 - Utilities	8
3E0X1 - Electrical Systems	4
3E1X1 - HVAC	2
3EXXX - Unspecified Labor	<u>30</u>
TOTAL LABOR HOURS REQUIRED:	44

FACILITY TITLE: Harvest Falcon Field Deployable Latrine

DESCRIPTION: Install field deployable latrine with tent and utilities.

SCOPE: 1 each (12 seats)

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E4X1 - Utilities	12
3E0X1 - Electrical Systems	4
3EXXX - Unspecified Labor	<u>36</u>
TOTAL LABOR HOURS REQUIRED:	52

FACILITY TITLE: Open Storage - Initial

DESCRIPTION: Hardstand, storage apron or taxiway, four-inch earth or stabilized crushed stone.

SCOPE: 1,000 sq yd

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E2X1 - Pavements and Construction Equipment	263
3E5X1 - Engineering	<u>8</u>
TOTAL LABOR HOURS REQUIRED:	271

FACILITY TITLE: Facility Revetment - Administrative Tent

DESCRIPTION: Provides for installation of 12-foot high revetment around facility.

SCOPE: 80 linear feet

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E2X1 - Pavements and Construction Equipment	54
3EXXX - Unspecified Labor	<u>54</u>
TOTAL LABOR HOURS REQUIRED:	108

FACILITY TITLE: Kennel - Initial

DESCRIPTION: Provides for 18 ft by 52 ft tent hardbacked with 2x4, concrete floor, and chain link fence kennels for holding individual security dogs.

SCOPE: 960 SF

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E2X1 - Pavements and Construction Equipment	68
3E3X1 - Structural	60
3EXXX - Unspecified Labor	<u>24</u>
TOTAL LABOR HOURS REQUIRED:	152

FACILITY TITLE: Electrical Power Plant - 750-kW Generator

DESCRIPTION: Provides van contained generator, 750 kW, includes 10,000-gal fuel bladder, primary distribution center, control panels, fuel bladder dike/berm.

SCOPE: 750 kW

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E2X1 - Pavements and Construction Equipment	4
3E4X2 - Liquid Fuels System Maintenance	2
3E0X1 - Electrical Systems	12
3E0X2 - Power Production	12
3EXXX - Unspecified Labor	<u>5</u>
TOTAL LABOR HOURS REQUIRED:	35

FACILITY TITLE: Electrical Power Plant - 1100-person

DESCRIPTION: Provides four 750-kW generators, two 10,000-gal fuel bladders, primary distribution center, control panels, dikes/berms.

SCOPE: 3,000 kW

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E2X1 - Pavements and Construction Equipment	8
3E4X2 - Liquid Fuels System Maintenance	8
3E0X1 - Electrical Systems	35
3E0X2 - Power Production	35
3EXXX - Unspecified Labor	<u>10</u>
TOTAL LABOR HOURS REQUIRED:	96

FACILITY TITLE: Electric Generator, 100 kW

DESCRIPTION: Provides for installation of skid-mounted 100 kW generator set.

SCOPE: 100 kW

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E0X1 - Electrical Systems	2
3E0X2 - Power Production	<u>2</u>
TOTAL LABOR HOURS REQUIRED:	4

FACILITY TITLE: Harvest Falcon Electrical Distribution System - 1,100-person.

DESCRIPTION: Provides installation of 32 secondary distribution centers, two primary distribution centers, facility panels and buried cabling for an 1,100-person installation.

SCOPE: 1,100-person electrical system - 1 each.

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E0X1 - Electrical Systems	560
3E0X2 - Power Production	<u>280</u>
TOTAL LABOR HOURS REQUIRED:	840

FACILITY TITLE: Harvest Eagle Electrical Distribution System - 1,100-person

DESCRIPTION: Provides A and B panel installation and all above-ground cabling for an 1,100-person installation.

SCOPE: 1,100-person electrical system - 1 each

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E0X2 - Power Production	20
3E0X1 - Electrical Systems	<u>100</u>
TOTAL LABOR HOURS REQUIRED:	120

FACILITY TITLE: Exterior Area Lighting

DESCRIPTION: Electrical materials for perimeter lighting assembly, includes seven 300w floodlights and six poles.

SCOPE: 1,100 linear feet

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E2X1 - Pavements and Construction Equipment	8
3E0X1 - Electrical Systems	<u>96</u>
TOTAL LABOR HOURS REQUIRED:	104

FACILITY TITLE: Harvest Falcon Air Conditioner.

DESCRIPTION: Install Harvest Falcon air conditioning unit.

SCOPE: 1 each (4.5 tons)

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E1X1 - HVAC	2
TOTAL LABOR HOURS REQUIRED:	2

FACILITY TITLE: M-80 Water Heater.

DESCRIPTION: Install M-80 water heater.

SCOPE: 1 each

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E1X1 - HVAC	1
TOTAL LABOR HOURS REQUIRED:	1

FACILITY TITLE: Remote Area Lighting System (RALS).

DESCRIPTION: Install RALS.

SCOPE: 1 each

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E0X1 - Electrical Systems	4
TOTAL LABOR HOURS REQUIRED:	4

FACILITY TITLE: Preway Heater.

DESCRIPTION: Install preway heater.

SCOPE: 1 each (70,000 BTUs)

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3EXXX - Unspecified Labor	1
TOTAL LABOR HOURS REQUIRED:	1

FACILITY TITLE: Sewage line

DESCRIPTION: Provides manhours to install a 65 gpm sewage lift pump with 50 ft of 4-inch hose.

SCOPE: 50 ft

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E4X1 - Utilities	40
3E0X1 - Electrical Systems	4
TOTAL LABOR HOURS REQUIRED:	44

FACILITY TITLE: Harvest Falcon Waste Collection System - 1,100-person.

DESCRIPTION: Provides four lift stations and approximately 24,000 ft of various sized collection pipe.

SCOPE: 1,100-person waste collection system - 1 each

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E5X1 - Engineering	40
3E4X1 - Utilities	750
3E2X1 - Pavements and Construction Equipment	120
3E0X1 - Electrical Systems	<u>16</u>
TOTAL LABOR HOURS REQUIRED:	926

FACILITY TITLE: Water Treatment Plant - Initial

DESCRIPTION: Provides for set-up of ROWPU.

SCOPE: 12,000 gal/day

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E2X1 - Pavements and Construction Equipment	2
3E4X1 - Utilities	12
3E0X1 - Electrical Systems	<u>2</u>
TOTAL LABOR HOURS REQUIRED:	16

FACILITY TITLE: Water Treatment Plant.

DESCRIPTION: Provides water treatment units, tanks, pumps, and operating chemicals for the purification of water at a rate of 1,800 gal/hr for a 20-hour day.

SCOPE: 36,000 gal/day

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E2X1 - Pavements and Construction Equipment	4
3E4X1 - Utilities	40
3E0X1 - Electrical Systems	<u>8</u>
TOTAL LABOR HOURS REQUIRED:	52

FACILITY TITLE: Harvest Eagle Water Distribution System - 1,100-person.

DESCRIPTION: Provides distribution hose, pumps, storage bladders and discharge points for an 1,100-person installation.

SCOPE: 1,100-person water distribution system

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E2X1 - Pavements and Construction Equipment	12
3E4X1 - Utilities	260
3E5X1 - Engineering	2
3EXXX - Unspecified Labor	<u>266</u>
TOTAL LABOR HOURS REQUIRED:	540

FACILITY TITLE: Harvest Falcon Water Distribution System - 1,100-person.

DESCRIPTION: Provides installation of approximately 35,000 ft of distribution pipe, pumps, and fittings for an 1,100-person installation.

SCOPE: 1,100-person water distribution system - 1 each

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E2X1 - Pavements and Construction Equipment	140
3E4X1 - Utilities	1080
3E0X1 - Electrical Systems	16
3E5X1 - Engineering	<u>40</u>
TOTAL LABOR HOURS REQUIRED:	1276

FACILITY TITLE: Water Storage - 20,000 gal

DESCRIPTION: Provides one 20,000-gal collapsible type potable water tank and necessary hose to interconnect with other tanks.

SCOPE: 20,000 gal

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E2X1 - Pavements and Construction Equipment	1
3E4X1 - Utilities	4
3EXXX - Unspecified Labor	<u>5</u>
TOTAL LABOR HOURS REQUIRED:	10

FACILITY TITLE: Water Storage - 12,000 gal

DESCRIPTION: Provides four 3,000-gal collapsible type, potable water tanks and necessary hose to interconnect tanks.

SCOPE: 12,000 gal

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E2X1 - Pavements and Construction Equipment	4
3E4X1 - Utilities	12
3EXXX - Unspecified Labor	<u>16</u>
TOTAL LABOR HOURS REQUIRED:	32

FACILITY TITLE: Water Storage - 3,000 gal

DESCRIPTION: Provides one 3,000-gal collapsible type potable water tank and necessary fill and discharge hose.

SCOPE: 3,000 gal

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E2X1 - Pavements and Construction Equipment	1
3E4X1 - Utilities	<u>4</u>
TOTAL LABOR HOURS REQUIRED:	5

FACILITY TITLE: Road, 2 Lanes, Stabilized

DESCRIPTION: One mile of two-lane road, 6-inch compacted earth or stabilized crushed stone. Includes various sizes of steel drainage culvert.

SCOPE: 1 mile

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E2X1 - Pavements and Construction Equipment	1,540
3E5X1 - Engineering	48
3EXXX - Unspecified Labor	<u>460</u>
TOTAL LABOR HOURS REQUIRED:	2,048

FACILITY TITLE: Lagoon.

DESCRIPTION: 33,000 SF evaporation lagoon, 1 foot deep.

SCOPE: 33,000 SF

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E2X1 - Pavements and Construction Equipment	72
3E4X1 - Utilities	<u>4</u>
TOTAL LABOR HOURS REQUIRED:	76

FACILITY TITLE: Munitions Berm

DESCRIPTION: Construct 30' x 30' earth berm, 5' high.

SCOPE: 900 SF

LABOR REQUIREMENTS:

<u>AFS</u>	<u>LABOR HOURS</u>
3E2X1 - Pavements and Construction Equipment	8
TOTAL LABOR HOURS REQUIRED:	8

FIRE PROTECTION

A21.1. Introduction. Firefighting forces have an exceptionally large responsibility during time of war or contingencies. They play a vital role in minimizing loss of life and property and preventing damage from fire that would seriously degrade mission capability at a base. Following an attack, the commander's first priority and the BCE's primary mission is to rapidly restore and sustain an aircraft launch and recovery capability. The immediate goal for firefighting forces is to protect assets to ensure weapons systems are able to regenerate to meet mission taskings.

A21.2. Planning Guidance. Determining the correct amount of Aircraft Rescue Fire Fighting (ARFF) support required for (American and allied) air bases in any conflict where multiple, simultaneous incidents involving damage to airplanes, fuel storage systems, munitions storage bunkers, facilities, utilities, and/or other equipment is, at best, an inexact science. Providing what would normally be considered optimum fire suppression capability to handle such incidents, while supporting aircraft operations, would require manpower and equipment resources that are not available. Planners must establish a listing of priorities, based on mission essentiality of assets, providing guidance for the decision making process facing senior fire officials during incidents that exceed a base's ability to respond. Existing installation fire protection forces will be maintained in a constant readiness posture to provide facility and ARFF services in response to any contingency or war situation.

A21.2.1 ARFF vehicles and equipment available for the initial phase of a contingency or wartime operations are those in-place or prepositioned. Additional vehicles and support equipment may be necessary during a conflict. Planners must identify shortfalls in firefighting equipment and vehicles through careful analysis of theater plans and support documents. They do this by determining the planned flying operations at each of their theater bases, the firefighting wartime vehicles required to support these operations, and unique requirements over and above those required to support the flying operations. They compare them against existing vehicles at each base and WRM assets prepositioned to support the anticipated wartime requirement. Note that existing vehicles need not be an exact match to those specified in this document. Senior fire officials may determine suitable substitutes. Planners, with the assistance of senior fire officials, must then identify these shortfalls by appropriate ARFF vehicle type.

A21.2.2. Specific aircraft operations (number of aircraft on the ground, aircraft size and fuel loads, sorties to be flown, etc.) at the beddown location determine theater wartime firefighter requirements. Table A21.1 reflects the fuel capacity and frame size for each type aircraft. Aircraft with larger fuel loads present the probability of larger fires and require greater quantities of firefighting agent. This may be provided through an increase in vehicle assets or by substituting vehicles of greater capacity than those provided.

Table A21.1. Aircraft Frame Size/Fuel Capacity.		
AIRCRAFT GROUPINGS		
GROUP 1 Small Frame Aircraft (less than 4,000 gal)	GROUP 2 Medium Frame Aircraft (4,001 - 15,000 gal)	GROUP 3 Large Frame Aircraft (15,001 or more gal)
A-7, A-10, A-37, AH-1G, AH-64, C-7, C-12, C-26, C-27, C-23A, C-131, C-140, CH-47, CH-54, DC-8, F-4, F-15, F-16, F-27, F-117, FH-227, HH-1H, HH-53, HU-15, O-2, OH-6, OH-58, OV-1, OV-10, T-37, T-41, T-42, T-43, TA-55, TR-1, U-1, U-3, U-4, U-6, U-8, U-9, U-10, U-17, U-21, UH-1, UH-21, UH-60A, WU-2	B-727, B737, C-19, C-20, C-130, DC-9, F-111, FB-111, L-188	B-1, B-2, B-52, B-707, B-720, B-747, C-5, C-17, C-135, C-137, C-141, DC-10, E-3A, E-4, KC-10, L-1011, MD-11, B-757, B-767
NOTE: Aircraft groupings are categorized by aircraft fuel loads to include tip and drop off tanks.		

Table A21.2 gives basic guidelines for required firefighting vehicles needed to support different types of aircraft operations.

A21.2.3. After vehicle types and numbers have been determined, table A21.3 is used to compute the number of firefighters required to support those vehicles.

A21.2.4. Firefighters are included in the civil engineer UTCs. The 24-person firefighter team is part of the 132 person or lead engineer UTC, and a 12-person firefighter team is part of the 61 person or follow engineer UTC. Air Force Reserve and Air National Guard firefighting teams are the same size and configuration but are postured separately from engineer UTCs. The firefighter portion of the lead UTC package is needed to provide around-the-clock operational support to a single squadron of small frame aircraft. As flying operations increase so will firefighting manpower and vehicle requirements. Additional follow firefighter UTCs will be required to properly staff those additional vehicles. If command-level firefighting assistance is required at a numbered Air Force or MAJCOM Headquarters, an S-5 team (3-person) supports this tasking. When sourcing theater manpower and vehicle requirements, MAJCOM planners should use the UTCs in WMP-3, Parts 2 and 3.

Table A21.2. Crash Fire Rescue Vehicle Decision Matrix.					
AIRCRAFT GROUPINGS (MAXIMUM AIRCRAFT ON THE GROUND)			MINIMUM RECOMMENDED FIRE VEHICLE**		
GROUP 1	GROUP 2	GROUP 3	ARFF P-4/19	COMMAND AND CONTROL	RESCUE
1 to 12			2*	1	
13 to 24	or 2 to 8	or 2	3*	1	1
25 or more	or 9 or more	or 3	4*	1	1
<p>* Fire protection requirements for any operations or combination of aircraft groupings not specified will be determined by the MAJCOM Fire Protection Representatives.</p> <p>**Decisions of vehicle type substitutions will be made by the MAJCOM Fire Protection Representative.</p> <p>NOTE 1: This vehicle matrix is used in the deliberate OPlan process to give planners the number and types of fire crash vehicles recommended in support of an identified number and type(s) of aircraft used during contingencies and regional conflicts. The actual number and types of vehicles deployed during a real world contingency crisis will depend on the type of contingency, threat, availability of fire vehicles and airlift, and acceptable risks that often drive planning decisions.</p> <p>NOTE 2: This matrix does not consider structural fire requirements. If structural fire protection is required, however, it can be provided by replacing a P-19 with a P-19B or by addition of a P-12, P-18, P-22, P-24, or P-27 vehicle.</p>					

A21.3. Theater Wartime Guidance. In a wartime theater of operations, USAF firefighting forces are a primary air base operability asset and are responsible for the protection of people, aircraft, facilities, materials, and equipment from the effects of fire caused by aircraft battle damages, enemy weapons effects, and other causes. Firefighting suppression and rescue response strategies will be complicated by the presence of chemical agents, antipersonnel devices, munitions, and sub-munitions with time-delayed or target-sensitive fusing. Critical decisions must be made concerning which fires are fought, which fires are allowed to burn, which people are rescued, and which people are left to buddy care. Fire department response to aircraft recovery operations on minimum operating strips will severely limit other support. In non-critical facilities, occupants and other non-firefighting personnel may be the only response available since it is unlikely that sufficient firefighting equipment or personnel will be available to extinguish multiple fires simultaneously.

Table A21.3. Fire Suppression Vehicle Position Manning.	
TYPE VEHICLE	MANNING
Aircraft Crash Firefighting	
P-2	3
P-4	3
P-19	3
P-23	3
Rescue	
P-10	3
P-20/13	2
Structural*	
P-8	4
P-12	4
P-22	4
P-24	4
P-27	4
Water Carrier	
P-18	1
P-26	1
Command and Control	
4x4 C/A	1
Support	
1-Ton w/Lift	1
NOTE: This table reflects the minimum manning assigned per vehicle.	

*Not typically found at a bare base location.

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